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AUTHOR	Abedi, Jamal
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ABSTRACT

Data from four different school sites nationwide were analyzed to examine whether standardized test results may be confounded by the lack of language proficiency of English language learners. Several analyses comparing the performance of limited English proficient (LEP) students and their non-LEP classmates revealed major differences. A Disparity Index was created to measure the performance gap between LEP and non-LEP students on tests with varying levels of language demand. The more linguistically complex the nature of the test, the greater was the Disparity Index of non-LEP students' results over LEP students'. This may suggest that high-language-load test items in assessments of content such as mathematics and science may act as a sources of measurement error. LEP students tended to have lower internal consistency scores on standardized assessments. Again, this suggests that item language load may interfere with testing the intended constructs. Using multiple regression, multivariate analysis of variance, and canonical correlation, researchers found that the more language load in a test, the stronger the confounding between LEP status and content-based performance on that test. Structural models for LEP student results demonstrated a lower statistical fit among test items, as well as between items and the total test scores. The factor loadings were generally lower for LEP students, and the correlations between the latent content-based variables were weaker as well. (Contains 36 figures, 106 tables, and 23 references.) (SLD)

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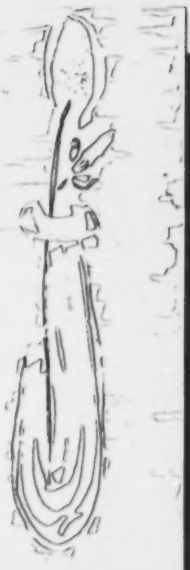

Impact of Student Language Background on Content-Based Performance: Analyses of Extant Data

CSE Report 603

Jamal Abedi
CRESST/University of California, Los Angeles

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Center for the Study of Evaluation
National Center for Research on Evaluation,
Standards, and Student Testing
Graduate School of Education & Information Studies
University of California, Los Angeles
Los Angeles, CA 90095-1522
(310) 206-1532

Project 4.2 Validity of Assessment and Accommodations
Jamal Abedi, Project Director, CRESST/University of California, Los Angeles

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Executive Summary

Research literature has suggested that the language background of students may impact performance on standardized assessments. The results of data analyses from several locations nationwide support the findings of existing literature which indicate that assessment results may be confounded by language background, particularly for those with limited English proficiency (LEP).[1]

Existing standardized test and student background data from four different school sites nationwide were obtained for analysis. To assure anonymity, these data sites will be referred to as Sites 1, 2, 3, and 4.

Site 1 is a large urban public school district that provided 1999 Iowa Tests of Basic Skills (ITBS) performance data, as well as background data, for Grades 3 through 8.

Site 2 is an entire state with a large number of LEP students that provided Stanford 9 test data for all students enrolled in Grades 2 through 11 in public schools for the 1997-1998 academic year. These data included responses to test items (item-level data), subsection scores, and background data. The background data included gender, ethnicity, socioeconomic status (SES)[2], parent education, LEP status, and students with disabilities (SWD) status.

Site 3 is an urban school district, with Stanford 9 test data available for all students in Grades 10 and 11 for the 1997-1998 academic year. These data included responses to test items (item-level data), subsection scores, background data, and test accommodation data.

Site 4 is a state with a large number of LEP students that provided Stanford 9 summary test data for all students in Grades 3, 6, 8, and 10, who were enrolled in the statewide public schools for the 1997-1998 academic year. Item-level data was available for a sample of the population for Grades 3, 5, 7, and 9 from the 1998-1999 academic year. Background data was also available from this site and included gender, ethnicity, SES level, and LEP, and SWD status.

There were both similarities and differences among the four data sites. Although they all used standardized tests for measuring school achievement in English and other content-based areas, they differed in the type of tests. Though they all had an index of LEP or bilingual status and provided background information, they differed in the type of index and the type of background variables provided. These differences may limit our ability to perform identical analyses at the

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[1] The term *limited English proficient* (LEP) is used primarily by government-funded programs to classify students, as well as by the National Assessment of Educational Progress (NAEP), for determining inclusion criteria. We acknowledge that this term may have a negative connotation. We also acknowledge that the broader term, *English language learner* (ELL) is preferred (see LaCelle-Peterson & Rivera, 1994). However, in keeping with its widespread use in NAEP testing, we use limited English proficient (LEP) to refer to students who are not native English speakers and who are at the lower end of the English proficiency continuum. Classification here is based on student background information obtained from participating schools.

[2] SES was determined by free/reduced lunch participation. Students who were eligible for any form of free or reduced lunch were categorized as *Low SES*. Students who were not eligible for free or reduced lunch were considered *Higher SES*.

different sites for cross validation purposes. However, there were enough similarities in the data structures at the four different sites to allow for interesting and valid comparisons.

The standardized tests that were used in the four sites were: the Stanford Achievement Test Series, Ninth Edition (Stanford 9 or SAT 9), ITBS, and the Language Assessment Scales (LAS). Among the background data that were provided by the sites were gender, ethnicity, birth date, and number of years of participation in a bilingual education program (number of years of bilingual services).

Descriptive statistics comparing LEP and non-LEP student (or bilingual and non-bilingual) performance by subgroup and across the different content areas revealed major differences. Disparity Indices (DI) of non-LEP over LEP students are included in the descriptive statistics section. These indices showed major differences between students with different language proficiency backgrounds. The more English language complexity involved in the assessment tool, the greater the DI.

In multiple regression models, LEP status was related to test scores and background variables. In a canonical correlation model, the relationship between LEP status, parent education, SES (the Set 2 variables), and SAT 9 performance (the Set 1 variables) was examined. The results of these analyses confirmed our earlier findings that the higher the English "language load" in the assessment, the larger the gap between performance of LEP and non-LEP students.

The term "language load" refers to the linguistic complexity of the test items.

Though we did not perform any linguistic analyses of test items, it is obvious that some test items (i.e., in reading assessments) involve more English language demand than in other content areas (i.e., math and science).

Several different analyses were performed on the available data, including descriptive statistics by LEP status, analyses of internal consistency of the measures by LEP status, and analyses comparing the structural relationships of the instruments across various LEP categories. Descriptive analyses showed that LEP students generally performed at a lower level than non-LEP students on reading, science, and math subtests—a strong indication of the impact of English language proficiency on assessment. The level of impact of language proficiency was especially greater in the content areas with high language demand. For example, analyses showed that LEP and non-LEP students had the greatest performance differences in reading. The gap between the performance of LEP and non-LEP students was smaller in other content areas with less language demand, such as math, which had the smallest difference.

The results of our analyses also indicate that test items for LEP students, particularly for students at the lower end of the English proficiency spectrum, suffer from lower internal consistency. That is, the language background of students may add another dimension to the assessment. Thus, we speculated that language might act as a source of measurement error in such cases.

Analyses of the structural relationships between individual items and between items with the total test scores showed a major difference between LEP and non-LEP students. Structural models for LEP students demonstrated lower

statistical fit. Further, the factor loadings were generally lower for LEP students and the correlations between the latent content-based variables were weaker as well.

The results of our analyses of data from the four sites were consistent with past literature and indicate that:

1. English language proficiency level is associated with performance on content-based assessments.
2. There is a performance gap in content assessment between LEP students and non-LEP students.
3. The performance gap between LEP students and non-LEP students increases as the language load of the assessment tools increases.
4. Test items high in language complexity may be sources of measurement error.
5. Performance on content-based assessments may be confounded with English language proficiency level.

IMPACT OF STUDENT LANGUAGE BACKGROUND ON CONTENT-BASED PERFORMANCE: ANALYSES OF EXTANT DATA

Jamal Abedi, Seth Leon, and Jim Mirocha

CRESST/University of California at Los Angeles

Abstract

We analyzed existing test data and student background data from four different school sites nationwide to examine whether standardized test results may be confounded by the lack of language proficiency of English language learners. Several analyses comparing the performance of limited English proficient (LEP) students and their non-LEP classmates revealed major differences. A Disparity Index was created to measure the performance gap between LEP and non-LEP students on tests with varying levels of language demand. The more linguistically complex the nature of the test, the greater was the Disparity Index of non-LEP students' results over LEP students'. This may suggest that high-language-load test items in assessments of content such as math and science may act as a source of measurement error. LEP students tended to have lower internal consistency scores on standardized assessments. Again, this suggests that item language load may interfere with testing the intended constructs. Using multiple regression, multivariate analysis of variance, and canonical correlation, we found that the more language load in a test, the stronger the confounding between LEP status and content-based performance on that test. Structural models for LEP student results demonstrated a lower statistical fit among test items, as well as between items and the total test scores. The factor loadings were generally lower for LEP students, and the correlations between the latent content-based variables were weaker as well.

Results of our analyses indicate that:

1. English language proficiency level is associated with performance on content-based assessments.
2. There is a performance gap in content assessment between LEP students and non-LEP students.
3. The performance gap between LEP students and non-LEP students increases as the language load of the assessment tools increases.
4. Test items high in language complexity may be sources of measurement error.
5. Performance on content-based assessments may be confounded with English language proficiency level.

Perspective

As most standardized, content-based tests are conducted in English and normed on native English speaking test populations, they may inadvertently function as English language proficiency tests. LEP students may be unfamiliar with scriptally implicit questions, may not recognize vocabulary terms, or may mistakenly interpret an item literally (Duran, 1989; Garcia, 1991). A first language of a student may also interfere with their understanding. For example, Schmitt and Dorans (1989) found that Hispanic students scored higher than Anglo students on Scholastic Aptitude Test (SAT) questions with *true* cognates (e.g., *metal*, which has the same meaning in both Spanish and English), while they scored lower on *false* cognates (e.g., *pie*, which means *foot* in Spanish). In general, LEP students may perform less well on tests because they read more slowly (Mestre, 1988).

In her language analysis of standardized achievement tests, Bailey (2000) used the term "language demand" and indicated that the language demand of standardized achievement tests could be a potential threat to the validity of these tests when administered to LEP students. Because of this source of threat, she added, the assessment may not present an accurate picture of LEP student content knowledge. Bailey elaborated on the concept of language demand as uncommon vocabulary, non-literal usage (idioms), complex or atypical syntactic structure, uncommon genre, or multi-clausal processing.

These language background factors are likely to reduce the validity and reliability of inferences drawn about the content-based knowledge of a student, as stated in the *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999, p.91).

> For all test takers, any test that employs language is, in part, a measure of their language skills. This is of particular concern for test takers whose first language is not the language of the test. Test use with individuals who have not sufficiently acquired the language of the test may introduce construct-irrelevant components to the testing process. In such instances, test results may not reflect accurately the qualities and competencies intended to be measured. Therefore, it is important to consider language background in developing, selecting, and administering tests and in interpreting test performance.

Previous Studies

In a series of previous National Center for Research on Evaluation, Standards, and Student Testing (CRESST) studies on the impact of language background on standardized test performance, we found that (a) language background factors affect performance in math, and (b) the pattern of responses differs across LEP and non-LEP categories (see Abedi & Lord, 2001; Abedi, Lord, & Hofstetter, 1997; Abedi, Lord, Hofstetter, & Baker, 2000; Abedi, Lord, & Plummer, 1997). For example, we found that the internal consistency coefficients for the math and reading tests were systematically lower for LEP students. We also found major differences between the structural relationship of responses of LEP and non-LEP students to the National Assessment of Educational Progress (NAEP) background questions. The fit indices were generally lower, and factor loadings of the item-parcels with the latent variables were weaker, for LEP students. Correlation coefficients between the latent variables were smaller for LEP students than for non-LEP students (Abedi & Leon, 1999; Abedi, Leon, & Mirocha, 2001). We believe that the level of English proficiency plays an important role in these results. That is, the difficulty in understanding the language of the test items creates another source of *measurement error* that results in lower reliability and validity of the measures.

The analyses reported earlier included descriptive statistics, analyses of internal consistency of the test items, and analyses comparing the structural relationship of the measures across all the English proficiency categories (i.e., LEP and non-LEP). These include Re-designated Fluent English Proficiency (RFEP), Fluent English Proficiency (FEP), and English Only (EO). Results of these analyses indicated that LEP students generally performed lower than non-LEP students in reading, science, math, and other content areas—a strong indication of the relationship of English proficiency with achievement measures. However, the level of impact[3] of language on assessment performance of LEP students was greater in those content areas with high language load. For example, analyses showed that LEP and non-LEP students have the greatest performance differences in reading. The gap between the performance of LEP and non-LEP students was smaller in other content areas where there is less language load. The difference between LEP and non-LEP performance was smallest in math, particularly math computation items, where language has less impact.

[3] By using the term *impact* we do not mean any causal relationships.

The results of our analyses also indicated that sub-test internal consistency reliabilities were lower among LEP students (particularly in the lower English language proficiency group) than among non-LEP students. That is, language background may add another dimension to performance assessment, wherein language might be a source of measurement error.

We obtained data from several other locations nationwide for further investigation. Analyzing the new data sets has enabled us to continue exploring the main question of our past studies: whether language background impacts performance on standardized achievement tests. The following sections are summaries of our analyses of the new data from Sites 1, 2, 3, and 4.

Data Sources

The data for this study were obtained from four locations:

Site 1. Site 1 is a large urban public school district. We obtained 1999 ITBS performance data for Grades 3 through 8. The data included responses to test items (item-level data), subsection scores, and background data. These subsection summary scores were grouped into four categories that included math concepts and estimation, math problem solving and data interpretation, math computation, and reading. Data were analyzed for Grades 3, 6, and 8. Students were also categorized based on whether or not they were receiving bilingual services. There were 36,065 students in Grade 3, of which 7,270, or about one in five, received bilingual services. In Grade 6, there were 28,313 students with 3,341 (11.8%) receiving bilingual services. And, in Grade 8, of the 25,406 students analyzed, 2,306, which is less than 1 in 10 (9.1%), were receiving bilingual services.

Site 2. Site 2 is an entire state with a large number of LEP students. The Department of Education for this state gave us access to the SAT 9 test data for all students in Grades 2 through 11 who were enrolled in the statewide public schools for the 1997-1998 academic year. These data included responses to test items (item-level data), subsection scores, and background data. The background data included gender, ethnicity, socioeconomic status (SES), parent education, LEP status, and students with disabilities (SWD) status. Scores were available at the subsection level for reading, math, language, spelling, science, and social science. Some of these subsection scores were not available for all grades. In this report, data were analyzed for Grades 2, 7, and 9. There were 414,169 students in Grade 2, of which 125,109

(30.2%) were labeled as LEP. In Grade 7, out of 349,581 students, 993 (21.2%) were LEP students. In Grade 9, there were 309,930 students available for analysis, with 57,991 (18.7%) LEP students.

Site 3. Site 3 is an urban school district. SAT 9 test data were available for all students in Grades 10 and 11 for the 1997-1998 academic year. These data included responses to test items (item-level data), subsection scores, accommodation data, and background data. The background data included gender, ethnicity, and LEP and SWD status. The accommodation data indicated both the type of accommodation used and the number received. Scores were available at the subsection level for reading, math, and science. Out of 12,919 students in Grade 10, 431 (3.3%) were labeled as LEP. In Grade 11, there were 9,803 students, of which 339 (3.5%) were LEP students.

Site 4. Site 4 is a state with a large number of LEP students. The Department of Education for this state gave us access to the SAT 9 summary test data for all students in Grades 3, 6, 8, and 10 who were enrolled in the statewide public schools for the 1997-1998 academic year. Item-level data were available for Grades 3, 5, 7, and 9 from the 1998-1999 academic year. Background data were also available from this site and included gender, ethnicity, SES, and LEP and SWD status. Scores were available at the subsection level for reading, math problem solving, and math procedures. There were 13,810 students in Grade 3, with 1,065 (7.7%) LEP students. In Grade 6, out of the 12,998 students, 813 (6.3%) were LEP students. In Grade 8, there were 12,400 students available for analysis, of which 807 (6.5%) were LEP students.

Because the type, content, and structure of the data files were different across the sites, we will discuss the structure of the data files and the results of analyses separately for each site.

Descriptive Analyses

Site 1

Data from the Site 1 urban public school district for Grades 3 through 8 for the 1999 student population were analyzed. The data included responses to ITBS test items, ITBS subsection scores, and background data. The background data included student ID number, gender, ethnicity, birthdate, and the number of years of participation in a bilingual education program (number of years of bilingual services). Other school- or test-related variables, such as school unit number, grade, test form, and test level were also included in the data files. Three forms of the ITBS were used in the 1999 Site 1 testing: Forms K, L, and M. This report focuses on Form M, which was taken by 98.6% of the students. Data were provided for Levels 7 through 14 of the ITBS. Each test level was given to students from various grades. However, each test level was associated primarily with a particular grade, as follows: Level 9 with Grade 3, Level 10 with Grade 4, Level 11 with Grade 5, Level 12 with Grade 6, Level 13 with Grade 7, and Level 14 with Grade 8. This report follows the primary association just described. For example, ITBS scores from grades other than Grade 8 were not analyzed for Level 14.

Data files from Site 1 did not include LEP status. However, the files included the number of years of bilingual services. As a proxy for LEP status, we created a bilingual status variable from the years of bilingual services as follows: a student with one or more years of bilingual services was designated "bilingual," and a student with no years of bilingual services was designated "non-bilingual." We also used another variable as a proxy for LEP status based on the number of years in bilingual education. Since participation in more bilingual classes may increase the level of language proficiency, students with less than 4 years of bilingual education were categorized as LEP and those with four or more years of bilingual education as non-LEP. However, the results of our analyses indicated that the mean score for students with more years in bilingual classes was significantly lower than the mean for students with fewer years in bilingual classes. We therefore decided to use the categorization based on receiving or not receiving bilingual education.

ITBS subsection (subtest) scores were reported in the following forms: (1) raw scores, (2) percentile ranks, (3) normal curve equivalent (NCE) scores, (4) stanine scores, and (5) grade equivalent scores. Scores were available at the subsection level

for math concepts and estimation, math problem solving and data interpretation, math computation, and reading.

Among the different subsection scores, we decided to analyze and report the NCE scores[4] because of consistency with the reports of data from the other sites (see Abedi & Leon, 1999). Some of the math scores were composites of more than one subsection score. For example, the total score of *math concepts and estimation* was a composite of two subtests, the *math concepts* subtest and the *math estimation* subtest. Similarly, the *math problem solving and data interpretation* score was a composite of the *problem solving* and *data interpretation* scores. Thus, there were originally five subsections in the math test. We report the descriptive statistics for the three subsections (*math concepts and estimation, math problem solving and data interpretation, and math computation),* but discuss the test item characteristics and internal consistency coefficients for the five math subtests separately.

Table 1 presents frequencies and percentages for students in Grades 3, 6, and 8 who took the ITBS tests by their bilingual status. As the data show, 36,065 students in Grade 3, 28,133 students in Grade 6, and 25,406 students in Grade 8 took the ITBS tests. Numbers and proportions of bilingual students differed across the grade levels. In Grade 3, more than 20% of students were bilingual. The percent of bilingual students decreased to about 12% in Grade 6, and further decreased to roughly 9% in Grade 8.

[4] NCEs are normalized standard scores with a mean of 50 and a standard deviation of 21.06. Because of their distributional properties, for analysis purposes NCEs are preferred over National Percentile ranks or raw scores. NCEs coincide with National Percentile ranks at the values 1, 50, and 99.

Table 1

Site 1 Grades 3, 6, and 8 ITBS Frequencies

	All students		Math concepts & estimation		Math prob. solv. & data interp.		Math computation		Reading	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
Grade 3										
Bilingual	7,270	20.2	7,248	79.9	7,254	79.8	7,260	79.8	7,261	79.8
Non-bilingual	28,795	79.8	28,733	20.1	28,694	20.2	28,740	20.2	28,745	20.2
All students	36,065	100.0	35,981	100.0	35,948	100.0	36,000	100.0	36,006	100.0
Grade 6										
Bilingual	3,341	11.8	3,338	88.2	3,335	88.2	3,337	88.2	3,330	88.2
Non-bilingual	24,792	88.2	24,935	11.8	24,915	11.8	24,924	11.8	24,942	11.8
All students	28,133	100.0	28,273	100.0	28,250	100.0	28,261	100.0	28,272	100.0
Grade 8										
Bilingual	2,306	9.1	2,300	90.9	2,300	90.9	2,303	90.9	2,291	91.0
Non-bilingual	23,100	90.9	23,036	9.1	23,033	9.1	23,039	9.1	23,071	9.0
All students	25,406	100.0	25,336	100.0	25,333	100.0	25,342	100.0	25,362	100.0

Table 2 presents the means, standard deviations, and number of students with non-missing NCE scores for the ITBS subsections at the various grade and test-level combinations. Bilingual students generally performed lower than the non-bilingual students. For the non-bilingual students, the overall mean NCE subsection score was 46.25 and ranged from 37.92 to 56.08, while for the bilingual students the mean score was 37.59 and ranged from 29.73 to 52.58.[5] However, the gap between the test scores of bilingual and non-bilingual students depended on the grade level and the content of the assessment. The difference between the mean NCE scores of bilingual and non-bilingual students was generally small for Grade 3 students, except in reading (where there was about a 7-point difference), and favored the non-bilingual group, except in math computation, where the mean was slightly higher for the bilingual group. Beginning with Grade 4, all the differences favored the non-bilingual students and generally grew larger as we moved to higher grades.

[5] Overall means for bilingual and non-bilingual students are averages computed across the six grade levels and the four ITBS subsections.

Table 2

Site 1 Grades 3-8 Descriptive Statistics for the ITBS Subsection NCE Scores

Test level	Grade	Bilingual status	Math Concepts & estimation	Math prob. solv. & data interp	Math computation	Reading
9	3	Non-bilingual				
		Mean	44.14	40.52	50.21	37.92
		SD	20.08	21.49	23.89	17.93
		N	28,733	28,694	28,740	28,745
		Bilingual				
		Mean	41.89	36.47	51.84	30.72
		SD	19.14	20.57	23.27	17.10
		N	7,248	7,254	7,260	7,261
10	4	Non-bilingual				
		Mean	44.12	45.47	56.08	45.44
		SD	20.41	17.77	24.13	15.70
		N	24,908	24,904	24,915	24,910
		Bilingual				
		Mean	34.84	38.31	52.58	34.85
		SD	18.81	15.67	23.90	12.77
		N	5,226	5,220	5,225	5,221
11	5	Non-bilingual				
		Mean	45.01	45.84	52.32	46.63
		SD	19.93	17.30	21.36	14.32
		N	22,037	22,022	22,035	22,021
		Bilingual				
		Mean	32.87	34.49	46.45	32.89
		SD	17.28	15.96	20.42	12.52
		N	3,850	3,848	3,848	3,844
12	6	Non-bilingual				
		Mean	45.20	43.94	50.82	42.66
		SD	20.53	18.57	21.02	16.14
		N	24,935	24,915	24,924	24,942
		Bilingual				
		Mean	35.41	33.69	45.60	29.73
		SD	17.57	14.30	18.47	12.50
		N	3,338	3,335	3,337	3,330
13	7	Non-bilingual				
		Mean	41.78	45.16	49.78	46.64

		SD	21.29	17.05	17.59	15.67
		N	23,457	23,442	23,435	23,479
		Bilingual				
		Mean	29.80	33.90	44.09	33.39
		SD	17.95	15.02	16.17	11.45
		N	2,308	2,307	2,307	2,310
14	8	Non-bilingual				
		Mean	48.36	47.50	49.13	46.59
		SD	19.31	15.97	16.39	15.19
		N	23,036	23,033	23,039	23,071
		Bilingual				
		Mean	37.08	35.94	43.52	32.69
		SD	16.07	13.59	14.77	12.52
		N	2,300	2,300	2,303	2,291

For example, the mean NCE math concepts and estimation score for Grade 3 non-bilingual students was 44.14 versus 41.89 for bilingual students—a small difference (about 2.5 score points higher for non-bilingual students). In Grade 3 reading, the non-bilingual students obtained a substantially higher mean (M = 37.92, SD = 17.93) than bilingual students (M = 30.72, SD = 17.10), a gap of approximately one-third of a standard deviation. In Grade 4, the reading gap becomes even larger. The mean reading score for non-bilingual students was 45.44 (SD = 15.70), compared with a mean of 34.85 (SD = 12.77) for bilingual students, a gap of more than two-thirds of a standard deviation.

Disparity index. The trend of increasing performance gaps between bilingual and non-bilingual students varied across the content/subsection areas. The largest gap between the two groups was in reading. This result was expected because the reading test items have presumably the highest language load among the four content areas, as presented in Table 1. Among these four content areas, the math computation subsection appears to have the lowest language load. Accordingly, the performance gap between bilingual and non-bilingual students was the smallest on the math computation subsection. To compare the score differences across test level, grade, and content area for bilingual and non-bilingual students, the percentage of Disparity Index (DI) of non-bilingual over bilingual students was obtained. The DI was computed by subtracting the bilingual subtest mean from the non-bilingual subtest mean, dividing the difference by the bilingual subtest mean, and multiplying

the result by 100. The result gives the percentage by which the non-bilingual group mean exceeds the bilingual group mean on that particular subtest. A negative DI indicates that the bilingual mean exceeds the non-bilingual mean.

Table 3 presents the DIs of non-bilingual students compared to bilingual student by test level, grade, and content area. The results present several interesting patterns:

1. Except for Grade 3 (Level 9) math computation, the DI percentages are all positive, indicating that the non-bilingual students generally outperformed the bilingual students.
2. Major differences between bilingual and non-bilingual students were found for Grades 3 and above. The difference between the mean scores of bilingual and non-bilingual students increased sharply by grade, up to Grade 6. Starting with Grade 6, the DI was still positive, but the rate of increase slowed down. For example, in Grade 3, non-bilingual students had DIs of 5.3% in math concepts and estimation, 11.1% in math problem solving and data interpretation, -3.1% in math computation (the bilingual group did better than the non-bilingual group on this subtest), and 23.4% in reading. In Grade 4, these indices increased to 26.9% for math concepts and estimation, 19.3% for math problem solving and data interpretation, 6.9% for math computation, and 30.1% for reading. The indices further increased in Grade 5 to 36.5% for math concepts and estimation, 32.7% for math problem solving and data interpretation, 12.6% for math computation, and 41.1% for reading.
3. As indicated earlier, the largest gap between bilingual and non-bilingual students was in reading. The next largest gaps were in the content areas that appear to have the next highest language load. The math concepts and estimation and the math problem solving and data interpretation subsections seem to have higher language load than the math computation subsection. Correspondingly, the DIs were higher for math concepts and estimation and for problem solving and data interpretation. The average DIs for Grades 3 through 8 was 27.7% for math concepts and estimation. That is, the non-bilingual group average in math concepts and estimation was 27.7% higher than the bilingual group average. A similar trend was observed in math problem solving and data interpretation; the average DIs for this subsection was 26.4%. The average DIs for math computation, however, was 9.0%, which is substantially lower than the corresponding DIs for the other two math subsections. The smaller gap between bilingual and non-bilingual students on the math computation subsection might be attributable to the lower language load of the math computation subsection.

Table 3

Disparity Indices of Non-Bilingual over Bilingual Students on Reading and Math Subsections

Test level	Primary grade	Math concepts & estimation	Math prob. solv. & data interp	Math computation	Reading
9	3	5.3	11.1	-3.1	23.4
10	4	26.9	19.3	6.9	30.1
11	5	36.5	32.7	12.6	41.1
12	6	27.5	30.9	11.8	43.7
13	7	39.4	32.7	12.9	39.6
14	8	30.5	31.7	12.9	42.7
Average of all levels/grades		27.7	26.4	9.0	36.8

Cumulative distribution functions. The average score on an indicator often masks important features of the distribution of scores on that indicator, such as the variability of scores and the shape of the distribution of scores. Graphical displays of the scores are therefore useful. A commonly used graphical display is a histogram of scores.

The cumulative distribution function (CDF) provides an effective display that shows the entire distribution of scores on an indicator. In probability theory, the CDF of a random variable X is defined as $F(x) = Pr(X \leq x)$, where x is in the domain of X. A graph of the CDF thus shows the proportion of scores at or below each value of the variable.

If {x1, x2,...xn} is a sample from a population, then the empirical cumulative distribution function (ECDF) is defined as $Fn(x) = (1/n)^*$ (number of $xi \leq x$). Fn(x) gives the proportion of the data less than or equal to x.

In this report, we were often interested in comparing the performance of two or more groups (samples) of students on an achievement test. Rather than simply comparing group means, we can learn much more by comparing the entire distributions of the groups. We will thus present the ECDFs for the groups. To standardize the comparisons, we utilized the national percentile rankings (NPRs) on the horizontal axis. We then plotted the ECDF on the vertical axis. Here are a few properties of such a plot.[6]

[6]Such a plot is also called a quantile-quantile (QQ) plot. For populations, the quantiles of one distribution are plotted against those of the other distribution. For samples from a population (or populations), the quantiles are based on the order statistics.

1. If the within group cumulative distribution percentile equals the NPR for all the data, then the graph of the ECDF is a straight diagonal line from the origin to the upper right corner of the graph.
2. If the ECDF graph lies wholly above the diagonal line, then the cumulative group percentile is greater than the NPR—this indicates that the group is performing less well than the national norming sample. For example, if the 30th NPR occurs at the 40th percentile in a group, then 40% of the group score at or below the 30th NPR.
3. If the ECDF graph lies wholly below the diagonal line, then the cumulative group percentile is less than the NPR—this indicates that the group is performing better than the national norming sample. For example, if the 30th NPR occurs at the 20th percentile in a group, then only 20% of the group score at or below the 30th NPR.
4. The further the ECDF is away from the diagonal line, the worse (above the diagonal) or better (below) the group is performing relative to the national norming sample.
5. The graph of the ECDF for a group may wander above and below the diagonal line, or towards or away from the diagonal line, indicating improving or worsening performance in particular subgroups.
6. The graph of an ECDF begins at the point (1,0) and ends at the point (99,100) because the lowest NPR is 1 and the highest NPR is 99.

Table 4

Site 1 ITBS Percentile Ranks for Bilingual Students at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Bilingual service	*N*	1st	2nd	3rd
Reading	3,324	9	18	30
Math concepts	3,324	10	28	47
Math problem solving	3,324	10	22	37
Math computation	3,324	25	40	59

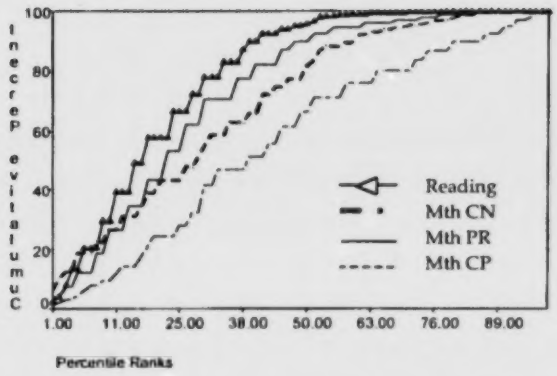

Figure 1. Site 1 bilingual CDFs by ITBS subsections.

Table 4 presents ITBS percentile ranks for bilingual students at the cumulative distribution quartiles and Table 5 presents the same data for non-bilingual students. As the data in Table 4 show, bilingual students obtained the lowest scores on reading, then math problem solving, then math concepts. They obtained the highest scores on math computation. Howevever, even on the math computation subscale, they scored substantially lower than the national norming sample. If all students performed identically to the norming sample, then the cumulative percentile ranks should correspond with the cumulative quartile columns. For example, under the 1st quartile, the percentile ranks should all be around 25; under the second, the percentile ranks should be 50; and under the 3rd quartile, the percentile ranks should be 75. Percentile ranks larger than these points would indicate that students performed better than the norming sample; percentile ranks lower than these are indicative of performance lower than the norming sample.

Figure 1 presents the cumulative distribution functions (CDF) based on the data from Table 1. The CDF percent curves for all four content areas (reading, math concepts, math probability, and math computation) were above the imaginary diagonal line; this indicates that the bilingual students performed below average on all four content areas. However, the distances between the CDF curves and the imaginary diagonal line differed across the content areas. The line for math computation was closest to the diagonal line, which suggests that bilingual students

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performed similarly to the norming sample on the math computation items but were below the norming sample on the other three areas. Thus, bilingual students perform considerably better on the math computation subsection when compared to the other subsections, which involve more language demand.

Table 5 presents Grade 6 percentile ranks for non-bilingual students. Comparing this data with the data in Table 4 shows that bilingual students perform lower than non-bilingual students. Figure 2 presents the cumulative distribution curves for non-bilingual students based on the data in Table 5. Major differences between the performances of bilingual and non-bilingual students are revealed by comparing Figure 1 (bilingual) with Figure 2 (non-bilingual).

Table 5

Site 1 Grade 6 ITBS Percentile Ranks for Non-Bilingual Students at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Bilingual service	*N*	1st	2nd	3rd
Reading	28,873	18	38	54
Math concepts	28,873	21	44	66
Math problem solving	28,873	18	37	57

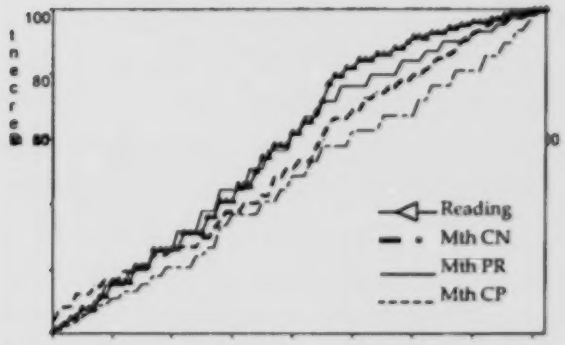

Figure 2. Site 1 Grade 6 non-bilingual CDFs by ITBS subsections.

For the non-bilingual students (Figure 2), the cumulative curves were closer to the diagonal line than those reported for bilingual students (Figure 1). This finding suggests that non-bilingual students in this study performed more similarly to the norming group. However, there were some differences in the performance of non-bilingual students across the four content areas. The cumulative curve for reading was above all other content cumulative curves indicating that even non-bilingual students performed lowest in reading. Similar to the findings for bilingual students, the non-bilingual students performed best on the math computation subscale.

Site 2

The Department of Education for Site 2 provided SAT 9 test data for all students in Grades 2 through 11 who were enrolled in the statewide public schools for the 1997-1998 academic year. This data included responses to SAT 9 test items (item-level data), subsection scores, and background data (student ID number, gender, ethnicity, SES, parent education, LEP and SWD status, home language survey, and district mobility). SAT 9 subsection scores were reported as (1) raw scores, (2) NPRs, and (3) normal curve equivalence (NCE) scores. Scores were available at the subsection level for reading, math, language, spelling, science, and social science. Some of these subsection scores were not available for all grades. NCEs were used in our analyses for the purpose of consistency with the other sites.

Table 6 and Table 7 present the number and percent of students in Grades 2, 7, and 9 who took the SAT 9 tests, by LEP and SWD status. Table 6 includes information for students with non-missing scores on the SAT 9 reading, math, and language subsections. Table 7 presents similar results for students with non-missing scores on the spelling, science, and social science subsections.

Table 6

Site 2 Grades 2, 7, and 9 SAT 9 Frequencies

	All students		Reading		Math		Language	
	N	%	*N*	%	*N*	%	*N*	%
Grade 2								
LEP only	120,480	29.1	97,862	26.5	114,519	28.4	107,861	27.5
SWD only	17,506	4.2	15,051	4.1	16,720	4.2	16,076	4.1
LEP/SWD	4,629	1.1	3,537	1.0	4,221	1.0	3,891	1.0
Non-LEP/Non-SWD	271,554	65.6	252,696	68.4	267,397	66.4	263,955	67.4
All students	414,169	100.0	369,146	100.0	402,857	100.0	391,783	100.0
Grade 7								
LEP only	66,410	19.0	62,273	18.5	64,153	18.9	62,559	18.7
SWD only	24,683	7.1	22,388	6.7	23,029	6.8	22,264	6.6
LEP/SWD	7,583	2.2	6,801	2.0	7,074	2.1	6,805	2.0
Non-LEP/Non-SWD	250,905	71.7	244,847	72.8	245,838	72.2	243,199	72.7
All students	349,581	100.0	336,309	100.0	340,094	100.0	334,827	100.0
Grade 9								
LEP only	53,457	17.2	48,801	16.6	50,666	17.0	48,909	16.7
SWD only	18,750	6.0	16,732	5.7	17,350	5.8	16,736	5.7
LEP/SWD	4,534	1.5	3,919	1.3	4,149	1.4	3,954	1.3
Non-LEP/Non-SWD	233,189	75.3	224,215	76.4	226,393	75.8	223,721	76.3
All students	309,930	100.0	293,667	100.0	298,558	100.0	293,320	100.0

As the data in Table 6 and Table 7 show, Site 2 provided us with a unique opportunity to examine the issues concerning LEP students. With a large number of LEP students, we could study the interaction of language with other background factors. The results of our analyses in the other three sites indicated that LEP status and SES (socioeconomic status) were highly correlated and, to some degree, confounded. Studying large numbers of students helps to understand the unique contributions of language factors above and beyond other background variables, such as SES. The number of LEP students was large in all grade levels, but more so in the lower grades. For example, in Grade 2 there were more than 120,000 LEP students (more than 25% of the total student population) taking the SAT 9 tests.

Table 7

Site 2 Grades 2, 7, and 9 SAT 9 Frequencies

	All students		Spelling		Science		Social science	
	N	%	*N*	%	*N*	%	*N*	%
Grade 2								
LEP only	120,480	29.1	109,198	27.5	NA	NA	NA	NA
SWD only	17,506	4.2	16,489	4.2	NA	NA	NA	NA
LEP/SWD	4,629	1.1	4,011	1.0	NA	NA	NA	NA
Non-LEP/Non-SWD	271,554	65.6	267,063	67.3	NA	NA	NA	NA
All students	414,169	100.0	396,761	100.0	NA	NA	NA	NA
Grade 7								
LEP only	66,410	19.0	64,359	18.8	22,006	21.4	18,293	21.1
SWD only	24,683	7.1	23,390	6.8	6,945	6.8	5,998	6.9
LEP/SWD	7,583	2.2	7,178	2.1	2,755	2.7	2,477	2.8
Non-LEP/Non-SWD	250,905	71.7	246,818	72.3	70,889	69.1	60,156	69.2
All students	349,581	100.0	341,745	100.0	102,595	100.0	86,924	100.0
Grade 9								
LEP only	53,457	17.2	16,035	18.6	50,179	16.9	49,859	16.9
SWD only	18,750	6.0	5,417	6.3	17,313	5.8	17,108	5.8
LEP/SWD	4,534	1.5	1,567	1.8	4,108	1.4	4,066	1.4
Non-LEP/Non-SWD	233,189	75.3	63,347	73.3	225,457	75.9	223,989	75.9
All students	309,930	100.0	86,366	100.0	297,057	100.0	295,022	100.0

Note. LEP = limited English proficient. SWD = students with disabilities.

These numbers were lower in Grade 7 (about 19% of the total population), and even lower in Grade 9 (about 17%). However, even in the higher grades, there are sufficient numbers of LEP students to permit meaningful analyses of test scores by the variety of background characteristics.

Data from students in Grades 2, 7, and 9 is used for discussion throughout this section of the report. Some analyses also incorporated the data from Grades 3 and 11. Table 8, Table 9, and Table 10 present descriptive statistics for LEP and SWD status, SES, and parent education for students in Grades 2, 7, and 9, respectively. The results of our analyses of the Site 2 data were consistent with the findings from the other three sites and suggest that language affects performance in the content areas.

Table 8

Site 2 Grade 2 SAT 9 Subsection Scores

Subgroup	Reading	Math	Language	Spelling
LEP status				
LEP				
M	31.6	37.7	31.6	33.7
SD	15.9	19.7	18.9	18.4
N	97,862	114,519	107,861	109,198
Non-LEP				
M	49.3	50.4	50.7	48.1
SD	19.7	21.9	23.2	20.1
N	252,696	267,397	263,955	267,063
SES				
Low SES				
M	35.4	38.8	35.5	36.7
SD	17.5	20.1	20.5	18.7
N	106,999	121,461	116,202	117,482
Higher SES				
M	47.0	48.5	48.0	46.0
SD	20.6	22.4	24.0	20.8
N	304,092	327,409	320,405	324,832
Parent education				
Not high school graduate				
M	30.1	34.7	29.9	31.4
SD	15.3	19.1	18.2	16.6
N	54,855	63,960	60,466	61,431
High school graduate				
M	40.5	42.6	40.8	40.7
SD	18.1	20.3	21.4	18.8
N	93,031	101,276	98,798	100,142
Some college				
M	48.8	50.3	50.5	47.8
SD	18.6	20.6	22.1	19.2
N	66,530	70,381	69,428	70,149
College graduate				
M	56.5	58.4	59.2	54.9
SD	18.5	20.6	21.8	19.8
N	54,391	56,451	55,803	56,345
Post graduate studies				
M	62.1	64.1	65.3	58.9
SD	18.7	20.4	21.2	20.1
N	25,571	26,367	26,141	26,336

Table 9

Site 2 Grade 7 SAT 9 Subsection Scores

Subgroup	Reading	Math	Language	Spelling
LEP status				
LEP				
Mean	26.3	34.6	32.3	28.5
SD	15.2	15.2	16.6	16.7
N	62,273	64,153	62,559	64,359
Non-LEP				
Mean	51.7	52.0	55.2	51.6
SD	19.5	20.7	20.9	20.0
N	244,847	245,838	243,199	246,818
SES				
Low SES				
Mean	34.3	38.1	38.9	36.3
SD	18.9	17.1	19.8	20.0
N	92,302	94,054	92,221	94,505
Higher SES				
Mean	48.2	49.4	51.7	47.6
SD	21.8	21.6	22.6	22.0
N	307,931	310,684	306,176	312,321
Parent education				
Not high school graduate				
Mean	31.2	36.2	36.4	32.8
SD	17.7	15.8	18.8	18.8
N	58,276	59,573	58,237	59,880
High school graduate				
Mean	39.3	40.9	42.9	40.2
SD	19.3	17.9	20.4	20.2
N	72,383	73,352	72,125	73,729
Some college				
Mean	49.1	49.0	52.2	48.5
SD	19.3	19.2	20.7	20.3
N	72,589	73,019	72,105	73,304
College graduate				
Mean	52.8	53.7	56.0	52.1
SD	20.4	21.3	21.6	20.9
N	82,417	82,804	81,855	83,110
Post graduate studies				
Mean	61.9	63.9	65.2	59.2
SD	20.6	22.2	21.2	20.8
N	39,443	39,609	39,319	39,697

Table 10

Site 2 Grade 9 SAT 9 Subsection Scores

Subgroup	Reading	Math	Language	Science	Social science
LEP status					
LEP					
Mean	24.0	38.1	34.8	34.9	34.5
SD	12.5	15.2	13.7	12.8	13.4
N	48,801	50,666	48,909	50,179	49,859
Non-LEP					
Mean	46.0	53.5	52.4	49.2	49.3
SD	18.0	19.4	17.7	16.1	17.9
N	224,215	226,393	223,721	225,457	223,989
SES					
Low SES					
Mean	32.0	42.5	41.0	39.4	39.3
SD	16.2	16.4	16.2	14.3	15.3
N	56,499	57,961	56,572	57,553	57,185
Higher SES					
Mean	42.6	50.7	49.2	47.0	46.9
SD	19.7	20.1	18.9	17.0	18.6
N	338,285	343,480	337,623	341,663	339,445
Parent education					
Not high school graduate					
Mean	29.2	39.6	38.3	37.3	37.2
SD	15.0	15.1	15.3	13.5	14.4
N	69,934	71,697	69,705	71,183	70,801
High school graduate					
Mean	35.6	44.1	42.9	41.7	41.0
SD	17.0	17.1	16.7	14.9	15.9
N	71,986	73,187	71,722	72,810	72,506
Some college					
Mean	44.6	51.6	50.5	48.2	47.7
SD	17.2	18.1	17.0	15.4	17.0
N	70,364	70,971	70,089	70,687	70,455
College graduate					
Mean	48.1	56.3	54.3	51.5	51.4
SD	18.5	19.6	18.1	16.4	18.2
N	87,654	88,241	87,354	87,956	87,746
Post graduate studies					
Mean	57.6	65.8	62.6	58.8	60.7
SD	19.6	20.7	18.6	17.1	19.7
N	34,978	35,087	34,910	35,022	35,005

The results reported in Table 8, Table 9, and Table 10 indicate that: (1) LEP students perform substantially lower than non-LEP students, particularly in content areas with more language load, such as reading; (2) the gap between the performance of LEP and non-LEP students is smaller in the lower grades; (3) LEP status may be confounded with SES and parent education.

To compare LEP and non-LEP students, we computed a Disparity Index (DI) by subtracting the mean score of LEP students from the mean of non-LEP students, dividing the difference by the mean of LEP students, and multiplying the result by 100. We used the DI to demonstrate the points stated above. Table 11 presents the DI by LEP status, as well as by SES and parent education, for Grades 2 and 7. Table 12 presents similar results for students in Grade 9.

Table 11

Site 2 Grades 2 and 7 DIs by LEP Status, SES, and Parent Education

Grade	DI	Reading	Math	Language	Spelling
2	LEP status	55.8	33.5	60.2	42.8
2	SES	32.7	25.1	35.2	25.3
2	Parent education	106.3	84.9	118.5	87.5
7	LEP status	96.9	50.4	70.7	81.1
7	SES	47.2	29.5	32.9	31.1
7	Parent education	98.4	76.2	79.0	80.5

Through a comparison of the math DI with the DI of the language related subsections (reading, language, and spelling), we can see the impact of language on performance. The DI of non-LEP students over LEP students was lower on the math subtest. For example, for Grade 2, the DI was 55.8% in reading (non-LEP students outperformed LEP students by 55.8%), 60.2% in language, and 42.8% in spelling, as compared with a DI of 33.5% in math. For Grade 7, the DIs were 96.9% for reading, 70.7% for language, and 81.1% in spelling, as compared to 50.4% for math (see Table 11). This trend also holds for Grade 9 (see Table 12).

In Table 8, Table 9, and Table 10, the mean, standard deviation by SES, and standard deviation by parent education are also reported. The DI for the SES variable (see Table 11 and Table 12) suggests that low SES students performed substantially higher than higher SES students. For Grade 2 students, these

Table 12

Site 2 Grade 9 DIs by LEP Status, SES, and Parent Education

Grade	DI	Reading	Math	Language	Science	Social science
9	LEP status	91.6	40.3	50.5	41.2	34.3
9	SES	33.3	19.8	19.9	19.3	19.4
9	Parent education	97.4	66.4	63.3	57.6	63.0

percentages were 32.7% in reading (low SES students performed 32.7% higher than higher SES students), 25.1% in math, 35.2% in language, and 25.3% in spelling (see Table 11). The corresponding DIs for Grade 7 were 47.2% for reading, 29.5% for math, 32.9% for language, and 31.1% for spelling. For Grade 9, the percentages were 33.3% for reading, 19.8% for math, 19.9% for language, 19.3% for science, and 19.4% for social sciences (see Table 12).

Parent education seems to have a much greater impact on student performance. The categories for the parent education variable were: not high school graduate, high school graduate, some college, college graduate, and post graduate studies. DIs for parent education were computed by subtracting the mean score of the lowest education category (not high school graduate) from the mean of the highest category (post graduate studies), dividing the difference by the mean from the lowest category, and multiplying the result by 100. For Grade 2 students, the DI was 106% in reading (students from parents with post graduate education performed 106% higher than those from parents with less than high school education), 85% in math, 119% in language, and 88% in spelling. Similar trends were found for students in Grades 7 and 9 (see Table 11 and Table 12).

LEP students may be more likely to have parents with a lower level of education. Thus, parent education and LEP status may be confounded. Similarly, LEP status may be confounded with SES, as LEP students may be more likely to be from families with lower SES. We will examine these hypotheses by applying more complex statistical models, such as canonical correlation and regression models.

To present a clearer picture of the differences between the performance of LEP and non-LEP students in conjunction with other background variables, a series of cumulative distribution tables and graphs was created. In these distributions, performance was compared across categories of LEP when SES and parent

education variables were controlled for. Table 13 presents a summary of the SAT 9 percentile ranks at the cumulative distribution quartiles for Grade 9 English only (EO) students with higher SES. Figure 3 shows a graphical representation of the data in Table 13. As the data in Table 14 indicate, percentile ranks were approximately at the quartiles, suggesting that the EO students performed roughly at the national level in all three content areas.

Figure 3 also shows that the three content curves were very close to the diagonal line. However, there was a slight improvement in the SAT 9 scores when we moved from reading to science and from science to math.

Table 13

Site 2 Grade 9 SAT 9 Percentile Ranks for EO/higher SES at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Sub-test	*N*	1st	2nd	3rd
Reading	157,847	23	45	69
Science	157,847	31	48	70
Math	157,847	32	58	80

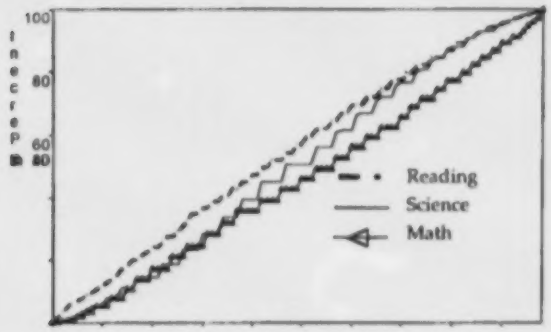

Figure 3. Site 2 Grade 9 SAT 9 CDFs for EO/Higher SES.

Table 14 presents data similar to those presented in Table 13, but for EO/low SES students. Thus, the difference between data in Table 13 and Table 14 is the

difference between SES. Figure 4 graphs the data in Table 14. A comparison of the data in Table 13 and Table 14 and Figure 3 and Figure 4 suggests, as expected, that SES has a substantial impact on performance. The percentile ranks for low SES students (Table 14) were consistently lower than the ranks for higher SES students (Table 13). For example, the percentile ranks for higher SES students at the 1st quartile were 23 for reading (about the national level), 31 for science, and 32 for math (slightly above the national level). However, for low SES students, the ranks were 11 for reading, 18 for science, and 18 for math, which are substantially lower than the national ranks. For both low and higher SES students, the reading scores were lower than science, and scores for science were lower than those for math. These are trends that were seen and discussed earlier for Site 1.

Table 14

Site 2 Grade 9 SAT 9 Percentile Ranks for EO/low SES at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Sub-test	*N*	1st	2nd	3rd
Reading	17,432	11	24	45
Science	17,432	18	35	54
Math	17,432	18	35	58

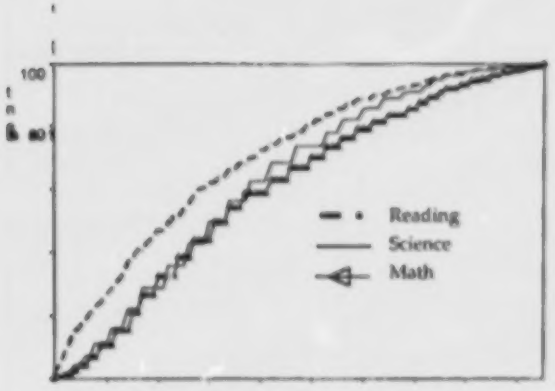

Figure 4. Site 2 Grade 9 SAT 9 CDFs for EO/low SES.

As presented in Table 13 and 14, the low SES group performed lower than the higher SES group among non-LEP students. Table 15 and Figure 5 present similar data for LEP students. For LEP students the reading scores were very low, and again science scores were lower than math.

Table 15

Site 2 Grade 9 SAT 9 Percentile Ranks for LEP Students at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Sub-test	*N*	1st	2nd	3rd
Reading	50,167	4	10	19
Science	50,167	12	23	35
Math	50,167	16	25	43

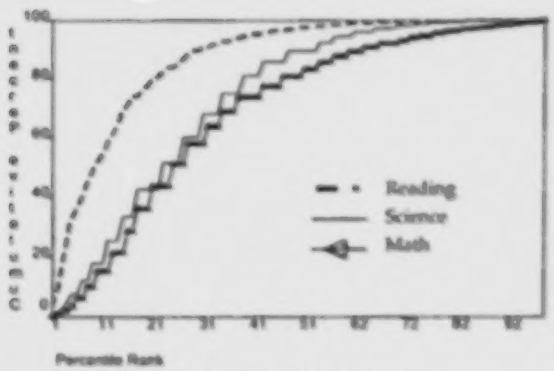

Figure 5. Site 2 Grade 9 Stanford 9 CDFs for LEP students.

A comparison of data in the three tables reveals that LEP students performed substantially lower than non-LEP students, even lower than the low SES group. For example, 11% of low SES students had percentile ranks at the 25th percentile points as compared with only 4% of LEP students at the 25th percentile point. At the 75th percentile point, there were 45% of low SES/non-LEP students as compared with only 19% of LEP students at this percentile point. However, the percentages at the different percentile levels improves as we move from language to science to math (see Table 13, Table 14, and Table 15.)

Table 16 and Figure 6 summarize the percentile rank statistics by parent education for higher EO/higher SES students. Table 17 and Figure 7 present similar results for EO/low SES students, whereas Table 18 and Figure 8 present the percentile rank statistics for the LEP group. As the data in Table 16 and Figure 6 show, parent education had substantial impact on performance, as shown by the percentile ranks. Percentile ranks at the lowest level of parent education were 8 (at the 25th point), 19 (at the 50th point), and 37 (at the 75th point), as compared with percentile ranks of 33, 57, and 77, respectively, for students with the highest level of parent education.

Table 16

Site 2 Grade 9 SAT 9 Percentile Ranks for EO/higher SES at Cumulative Distribution Quartiles, by Parent Education

		Quartiles		
Parent education	*N*	1st	2nd	3rd
Not high school graduate	10,154	8	19	37
High school graduate	28,064	14	28	51
Some college	36,266	24	44	65
College graduate	66,156	33	57	77

Note. EO = English only.

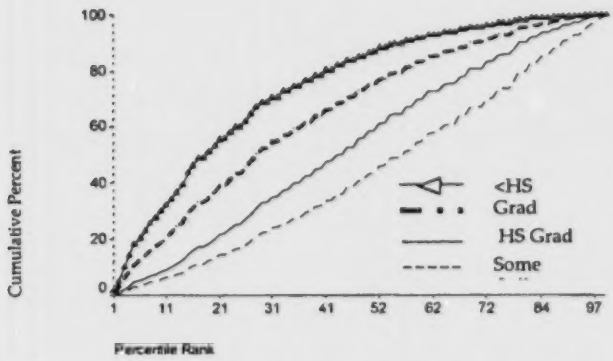

Figure 6. Site 2 Grade 9 SAT 9 CDFs for EO/higher SES by parent education.

Table 17 and Figure 7 present percentile ranks by categories of parent education for low SES students. Comparing data in Table 17 with those reported in

Table 16 for higher SES students reveals that, in general, low SES students performed lower than higher SES students academically. However, in the low SES group, parent education made a substantial difference. As Table 17 shows, the percentile ranks for students of parents with a high school education (lower level of education) were 6 (at the 25th percentile point), 15 (at the 50th percentile point), and 31 (at the 75th percentile point), as compared with percentile points of 14, 31, and 54, respectively, for students with parents with a higher level of education.

Table 17

Site 2 Grade 9 SAT 9 Percentile Ranks for EO/low SES at Cumulative Distribution Quartiles, by Parent Education

		Quartiles		
Parent education	*N*	1st	2nd	3rd
Not high school graduate	2,835	6	15	31
High school graduate	4,859	9	20	39
Some college	4,046	15	30	52
College graduate	3,906	14	31	54

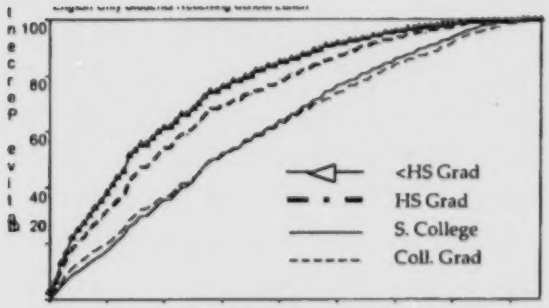

Figure 7. Site 2 Grade 9 SAT 9 CDFs for EO/low SES by parent education.

Table 18 and Figure 8 present percentile points by level of parent education for LEP students. As data in Table 18 suggest, the level of parent education impacts the performance of LEP students. LEP students with a higher level of parent education perform better than LEP students with a lower level of parent education.

For example, percentile ranks at the first three quartiles for students with parents of high school education were 4, 9, and 16, as compared with the percentile ranks of 6, 14, and 27 for LEP students with higher level of parent education at the three quartiles, respectively.

Table 18

Site 2 Grade 9 SAT 9 Percentile Ranks for LEP at Cumulative Distribution Quartiles, by Parent Education

		Quartiles		
Parent education	*N*	1st	2nd	3rd
Not high school graduate	23,706	4	9	16
High school graduate	9,668	4	10	19
Some college	3,725	6	14	25
College graduate	5,745	6	14	27

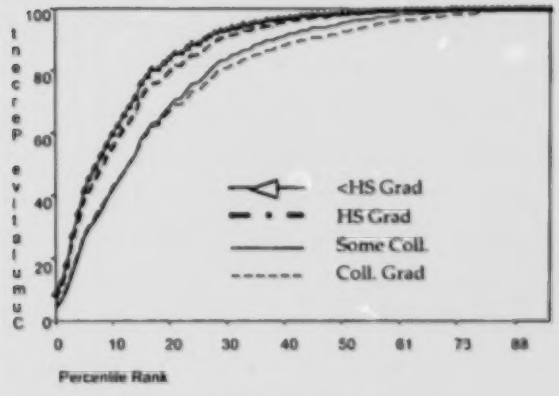

Figure 8. Site 2 Grade 9 SAT 9 CDFs for LEP by parent education.

Site 3

SAT 9 test data for students in Grades 10 and 11 were analyzed. The data included item-level data, subsection scores, and background data. Background data included gender, ethnicity, and LEP and SWD status. This site also provided us with information on accommodations used for LEP and SWD students. Similar to Site 2, we analyzed the SAT 9 NCE scores for the content areas of reading, science, and math.

Table 19 presents the number of students who took the SAT 9 tests. The numbers are broken down by LEP and SWD status. A total of 12,919 Grade 10 students were tested. Of these students, 391 (3.0%) were categorized by the school district as LEP, 1,100 (8.5%) as SWD, and 40 (0.3%) as LEP/SWD. Most of the students answered SAT 9 test items in the three main content areas: reading, math, and science. In Grade 11, a total of 9,803 students took the tests. Of these students, 310 (3.2%) were categorized as LEP, 800 (8.2%) as SWD, and 40 (0.3%) as LEP/SWD. As in Grade 10, the number of students taking the different subtests of the SAT 9 differed slightly.

Table 20 presents the means and standard deviations of the SAT 9 NCE test scores in the three content areas according to SWD and LEP status. The mean scores for reading, science, and math for all students in Grade 10 were 36.0 (*SD* = 16.9), 41.3 (*SD* = 17.5), and 38.5 (*SD* = 17), respectively.

Table 19

Site 3 Grades 10 and 11 SAT 9 Frequencies

	All Students		Reading		Science		Math	
	N	%	*N*	%	*N*	%	*N*	%
Grade 10								
LEP only	391	3.0	330	3.0	285	2.8	340	3.3
SWD only	1,100	8.5	812	7.3	595	5.8	595	5.8
LEP/SWD	40	0.3	19	0.2	17	0.2	22	0.2
Non-LEP/SWD	11,388	88.2	9,997	89.5	9,334	91.2	9,344	90.7
All students	12,919	100.0	11,158	100.0	10,231	100.0	10,301	100.0
Grade 11								
LEP only	310	3.2	289	3.3	248	3.1	277	3.4
SWD only	800	8.2	624	7.1	471	6.0	452	5.6
LEP/SWD	29	0.3	15	0.2	6	0.1	13	0.2
Non-LEP/SWD	8,664	88.3	7,812	89.4	7,175	90.8	7,298	90.8
All students	9,803	100.0	8,740	100.0	7,900	100.0	8,040	100.0

Table 20

Site 3 Grades 10 and 11 Descriptive Statistics for the SAT 9 NCEs

	Reading		Science		Math	
	M	*SD*	*M*	*SD*	*M*	*SD*
Grade 10						
LEP only	24.0	16.4	32.9	15.3	36.8	16.0
SWD only	16.4	12.7	25.5	13.3	22.5	11.7
LEP/SWD	16.3	11.2	24.8	9.3	23.6	9.8
Non-LEP/SWD	38.0	16.0	42.6	17.2	39.6	16.9
All students	36.0	16.9	41.3	17.5	38.5	17.0
Grade 11						
LEP only	22.5	16.1	28.4	14.4	45.5	18.2
SWD only	14.9	13.2	21.5	12.3	24.3	13.2
LEP/SWD	15.5	12.7	26.1	20.1	25.1	13.0
Non-LEP/SWD	38.4	18.3	39.6	18.8	45.2	21.1
All students	36.2	19.0	38.2	18.9	44.0	21.2

For LEP/SWD students, the mean scores in all three subscales were substantially lower than the mean scores for non-LEP/non-SWD students. Because the focus of this report is on LEP students, we will discuss the data as related to students classified as "LEP only." However, we will report data for both LEP and SWD students to the extent possible.

The mean scores for the Grade 10 LEP only students for reading, science, and math were 24.0 (*SD* = 16.4), 32.9 (*SD* = 15.3), and 36.8 (*SD* = 16.0), respectively. These data suggest two interesting trends: first, that test scores for LEP students increase as we move from reading to science to math; and second, that the difference between the performance of LEP and non-LEP students decreases from reading to science to math.

Table 20 also presents means and standard deviations for Grade 11, which were very similar to Grade 10. The mean scores for all students in Grade 11 for reading, science, and math were 36.2 (*SD* = 19.0), 38.2 (*SD* = 18.9), and 44.0 (*SD* = 21.2), respectively. Like Grade 10, the means of subscale scores increase as we move from reading to science to math. For science, there was a 6-score-point increase over reading (.4 standard deviation); and for math, there was a 23-score-point increase (1.5 standard deviation) over reading and a 17-score-point increase (1.1 standard

deviation) over science. This trend of increase in subscale score is due to several factors including content and language factors. The language factors are particularly important for the LEP group.

There were large differences between LEP/SWD and non-LEP/non-SWD groups in mean scores on the SAT 9 reading test. Among the three LEP/SWD categories, students in the "SWD only" category performed the lowest in reading. The mean reading score for this group was 14.9 as compared with a mean of 38.4 for non-LEP/non-SWD students, a difference of more than 1.5 standard deviations. In science, SWD only students again obtained the lowest mean score of all the other groups (M = 21.5, SD = 12.3); however, the difference between means for this group and the non-LEP/non-SWD group (M = 39.6, SD = 18.8) was smaller than the difference that was found between the two groups in reading. The difference between SWD and non-LEP/non-SWD mean scores decreases even further when we move from reading to math content area (for SWD only, M = 24.3, SD = 13.2).

Again, because the focus of this report is on LEP students, in the discussion of psychometric characteristics and subsequent analyses, we limit our discussion to comparisons involving LEP students only. In reading, there was a large difference between the scores of LEP and non-LEP students. The mean reading score for LEP students was 22.5 (SD = 16.1), as compared with a mean score of 38.4 (SD = 18.3) for non-LEP/non-SWD, a difference of about one standard deviation. This difference was only .69 standard deviations in science, and nonexistent in math. That is, in Grade 11 math, LEP (M = 45.5, SD = 18.2) and non-LEP/non-SWD (M = 45.2, SD = 21.1) students performed about the same (Table 20).

To present a clearer picture of differences between the performance of LEP and non-LEP students, Disparity Indices were computed. The DIs shown in Table 21 suggest that the higher the level of language load in the assessment, the larger the gap between the performance of LEP and non-LEP students. For example, for both Grade 10 and 11, the DI was largest for reading (58.3 for Grade 10 and 70.7 for Grade 11), smaller for science (29.5 for Grade 10 and 39.4 for Grade 11) and almost zero for math (7.6 for Grade 10 and –0.7 for Grade 11).

Table 21

Disparity Index Non-LEP/Non-SWD Students Compared to LEP Only Students

	Disparity index		
Grade	Reading	Science	Math
10	6	15	31
11	9	20	39

Descriptive statistics on accommodation data. The data from Site 3 provided an excellent opportunity to examine the impact of language background on performance. The data, however, had some limitations, as with data from any other large school district in the nation. One of the major limitations in the data was the lack of a control group in accommodation. For example, it was impossible to measure the impact of accommodation on the performance of accommodated students due to the lack of a baseline (either a pretest score for the accommodated students or a comparison group). Another limitation with the data was the small number of accommodated students. Having these limitations in mind, we performed some analyses on the accommodation data. Following are some of the findings.

Table 22 compares the performance in reading of LEP students under three different types of accommodation with non-LEP students (non-accommodated) in Grades 10 and 11. The accommodations are (a) extension of allotted time, (b) multiple shortened periods, and (c) simplified directions. For Grade 10 students, the mean NCE score for the non-LEP group is 38.04 (n = 9,957). For the accommodated LEP students, the mean NCE scores were substantially lower than the mean scores for both the non-accommodated LEP students and the non-LEP group. The mean for LEP students receiving "extension of allotted time" was 16.42 (n = 143); "multiple shortened period" was 15.74 (n = 52); and "simplified directions" was 15.81 (n = 133). Thus, LEP students had the lowest performance under the "multiple shortened period" accommodation and the highest performance under the "extension of time" accommodation. However, the differences in performances under the three accommodation conditions were very small, suggesting that the three forms of accommodation produced similar results.

Table 22

Site 3 Reading Normal Equivalent Means by Type of Accommodation (Any)

	Grade 10		Grade 11	
Accommodation type	*N*	Mean	*N*	Mean
Non-LEP: No accommodation	9,957	38.04	7,775	38.47
LEP: No accommodation	175	30.98	154	28.28
LEP: Any accommodation	155	16.15	135	15.91
LEP: Extension of allotted time	143	16.42	107	14.03
LEP: Multiple shortened periods	52	15.74	34	19.89
LEP: Simplified directions	133	15.81	125	16.29

Note. SWD students have been excluded from this analysis.

The overall mean NCE score for Grade 10 LEP students receiving any accommodation was 16.15, which is well below the mean NCE score of 38.04 for the non-LEP students, a difference of over 1.3 standard deviations. The mean NCE score for accommodated LEP students (16.15) was also considerably lower than the mean score for non-accommodated LEP students (30.98). The very large difference between the performance of non-LEP and LEP students may suggest that the accommodation strategies failed to narrow the gap between the two groups. It seems more likely however, given the large difference between the accommodated and the non- accommodated LEP students, that the accommodated LEP students were the lowest performing group from the outset. However, the effectiveness of accommodations cannot be judged without a baseline measure of language proficiency.

Similar results were obtained for Grade 11 students. The highest mean for LEP students in Grade 10 (M = 16.42, n = 143) was with the "extension of allotted time" accommodation, whereas, for students in Grade 11, this accommodation produced the lowest mean (M = 14.03, n = 107). However, as was the case for Grade 10 LEP students, the difference in the scores under the three types of accommodation is not large. The overall mean for Grade 11 accommodated LEP students was 15.91 (n = 135) as compared with a mean of 28.28 (n = 154) for non-accommodated LEP students and 38.47 (n = 7,775) for the non-LEP students.

Table 23 presents mean NCE science scores by type of accommodation for students in Grades 10 and 11. Several types of accommodation were utilized in science assessment. The mean score for non-LEP students in Grade 10 was 42.63 (n =

9,300). For LEP students, mean NCE scores under the different types of accommodation were (a) extension of allotted time: $M = 27.32$ ($n = 84$); (b) multiple shortened periods: $M = 28.50$ ($n = 39$); (c) simplified directions: $M = 27.87$ ($n = 109$); (d) reading of questions: $M = 27.13$ ($n = 52$); (e) translation of words/phrases: $M = 28.95$ ($n = 90$); (f) decoding of words: $M = 26.60$ ($n = 57$); and (g) use of gestures: $M = 27.84$ ($n = 65$). The overall science mean for LEP students, under these seven types of accommodation, was 28.01 ($n = 122$), as compared with a mean of 42.63 ($n = 9,300$) for the non-LEP group. Again, the accommodated LEP students scored substantially lower than both the non-accommodated LEP students and the non-LEP students.

Table 23 also reports data for students in Grade 11. The mean NCE science score for non-LEP students was 39.67 ($n = 7,143$). For LEP students, the means were (a) extension of allotted time: $M = 23.18$ ($n = 85$); (b) multiple shortened periods: $M = 28.77$ ($n = 26$); (c) simplified directions: $M = 24.19$ ($n = 106$); (d) reading of questions: $M = 22.62$ ($n = 54$); (e) translation of words/phrases: $M = 22.88$ ($n = 79$); (f) decoding of words: $M = 21.80$ ($n = 59$); and (g) use of gestures: $M = 23.56$ ($n = 40$). The mean for all Grade 11 accommodated LEP students was 24.26, as compared with a mean of 39.67 for the non-LEP students—a gap of 15.41, or about 1 standard deviation. The gap between the LEP and non-LEP groups however, was smaller in science scores than in reading scores, which were reported earlier.

Table 23

Site 3 Science NCE Means by Type of Accommodation (Any)

	Grade 10		Grade 11	
Accommodation type	*N*	Mean	*N*	Mean
Non-LEP: No accommodation	9,300	42.63	7,143	39.67
LEP: No accommodation	163	36.64	136	31.80
LEP: Any accommodation	122	28.01	112	24.26
LEP: Extension of allotted time	84	27.32	85	23.18
LEP: Multiple shortened periods	39	28.50	26	28.77
LEP: Simplified directions	109	27.87	106	24.19
LEP: Reading of questions	52	27.13	54	22.62
LEP: Translation of words/phrases	90	28.95	79	22.88
LEP: Decoding of words	57	26.60	59	21.80
LEP: Use of gestures	65	27.84	40	23.56

Note. SWD students have been excluded from this analysis. Single accommodation *N*'s will not sum to total as students are allowed multiple accommodations.

Table 24 summarizes the results of descriptive statistics for NCE math scores by seven types of accommodation for Grades 10 and 11. The mean math NCE score for non-LEP students in Grade 10 was 39.61 (n = 9,305). For LEP students, means by accommodations were (a) extension of allotted time: M = 31.83 (n = 116); (b) multiple shortened periods: M = 35.83 (n = 50); (c) simplified directions: M = 34.88 (n = 160); (d) reading of questions: M = 32.56 (n = 61); (e) translation of words/phrases: M = 35.69 (n = 128); (f) decoding of words: M = 31.80 (n = 68); and (g) use of gestures: M = 32.19 (n = 72). The mean NCE score over all types of accommodation for Grade 10 students was 34.61, as compared with a mean of 39.61 for non-LEP students, a difference of 5.00, which is about one third of a standard deviation.

Analyses for students in Grade 10 were also done for students in Grade 11. Table 24 reports the math NCE means and number of students taking the test. For non-LEP students, the mean was 45.18 (n = 7,264). For LEP students, the means were (a) extension of allotted time: M = 44.79 (n = 104); (b) multiple shortened periods: M = 46.35 (n = 35); (c) simplified directions: M = 46.09 (n = 128); (d) reading of questions: M = 43.53 (n = 71); (e) translation of words/phrases: M = 45.35 (n = 93); (f) decoding of words: M = 43.09 (n = 75); and (g) use of gestures: M = 45.91 (n = 47). The mean NCE math score for all accommodated LEP students was 46.01 (n = 135), as compared with a mean of 45.18 (n = 7,264) for the non-LEP students.

Table 24

Site 3 Math NCE Means by Type of Accommodation (Any)

	Grade 10		Grade 11	
Accommodation type	*N*	Mean	*N*	Mean
Non-LEP: No accommodation	9,305	39.61	7,264	45.18
LEP: No accommodation	168	39.11	142	44.93
LEP: Any accommodation	172	34.61	135	46.01
LEP: Extension of allotted time	116	31.83	104	44.79
LEP: Multiple shortened periods	50	35.83	35	46.35
LEP: Simplified directions	160	34.88	128	46.09
LEP: Reading of questions	61	32.56	71	43.53
LEP: Translation of words/phrases	128	35.69	93	45.35
LEP: Decoding of words	68	31.80	75	43.09
LEP: Use of gestures	72	32.19	47	45.91

Note. SWD students have been excluded from this analysis.

The results of these analyses may suggest that accommodations did not help to reduce the gap between the LEP and non-LEP groups, particularly in reading and science content areas. However, this conclusion is not warranted since we did not have access to the complete information needed to make such judgments. We had no baseline data against which to compare the accommodated assessment data. It may be that the students chosen to receive accommodations were less proficient in English than those who did not. Accommodations may have actually helped LEP students, and the gap between LEP and non-LEP students could have been much greater had no accommodations been provided.

An alternative way to examine the effectiveness of accommodations is to compare different groups of LEP students who received different numbers of accommodations. Students received one, two, or more than two accommodations. If accommodations are effective, then students receiving more accommodations should demonstrate a better performance. To test this hypothesis, we computed mean NCE scores for students receiving different numbers of accommodations. Table 25 shows mean NCE reading scores for Grades 10 and 11 by the number of accommodations received. Mean NCE scores were reported for non-LEP students (no accommodation), LEP students (no accommodation), LEP students (any accommodation), LEP students receiving one accommodation (of any type), LEP students receiving two accommodations, and LEP students receiving three accommodations.

Table 25

Site 3 Reading NCE Means by Number of Accommodations

	Grade 10		Grade 11	
Accommodation #	*N*	Mean	*N*	Mean
Non-LEP: No accommodation	9,957	38.04	7,775	38.47
LEP: No accommodation	175	30.98	154	28.28
LEP: Any accommodation	155	16.15	135	15.91
LEP: 1 Accommodation	33	16.62	31	22.07
LEP: 2 Accommodations	71	16.13	77	11.17
LEP: 3 Accommodations	51	15.89	27	22.34

Note. SWD students have been excluded from this analysis.

As shown in Table 25, the mean NCE reading score for non-LEP students (no accommodation) was 38.04 (n = 9,957). For LEP students receiving one accommodation, the mean was 16.62 (n = 33), two accommodations was 16.13 (n = 71), and three accommodations was 15.89 (n = 51). These results suggest that there may not be a systematic impact of the number of accommodations on reading scores. The increase or decrease in the means may also be due to chance since the numbers of students in the cells were relatively small.

Also reported in this table are NCE reading score means by number of accommodations for Grade 11. The mean for non-LEP students is 38.47 (n = 7,775), for LEP students with one accommodation 22.07 (n = 31), with two accommodations 11.17 (n = 77); and with three accommodations 22.34 (n = 27). The trends of NCE means for Grade 11 are inconsistent with those reported for Grade 10 and with the hypothesized direction that more accommodations means higher performance.

Table 26 presents NCE mean science scores by number of accommodations for Grades 10 and 11. Means are reported for non-LEP students (no accommodation), LEP students (no accommodation), LEP students (any accommodation), and LEP students receiving one to seven accommodations.

Table 26

Site 3 Science NCE Means by Number of Accommodations

	Grade 10		Grade 11	
Accommodation #	*N*	Mean	*N*	Mean
Non-LEP: No accommodation	9,300	42.63	7,143	39.67
LEP: No accommodation	163	36.64	136	31.80
LEP: Any accommodation	122	28.01	112	24.26
LEP: 1 accommodation	6	30.38	2	30.10
LEP: 2 accommodations	25	26.94	38	24.74
LEP: 3 accommodations	21	29.42	15	33.50
LEP: 4 accommodations	18	28.08	2	4.05
LEP: 5 accommodation	12	28.86	18	19.83
LEP: 6 accommodations	35	28.50	31	21.62
LEP: 7 accommodations	5	18.98	6	20.02

Note. SWD students have been excluded from this analysis.

As Table 26 shows, for grade, the mean for non-LEP students was 42.63 (n = 9,300). For LEP students, the means were 30.38 (n = 6) with one accommodation, 26.94 (n = 25) with two, 29.42 (n = 21) with three, 28.08 (n = 18) with four, 28.86 (n = 12) with five, 28.50 (n = 35) with six, and 18.98 (n = 5) with seven accommodations. There was no systematic trend on the means. With one accommodation, LEP students had the highest mean score (30.38). This lack of a meaningful trend may be due to the small number of students in the seven LEP categories, or due to the lack of impact of accommodations on performance, or both. The overall mean (over the total number of accommodations) for LEP students was 28.01 (n = 122) as compared with a mean of 42.63 for non-LEP students (n = 9,300).

NCE science means by number of accommodations are also reported for Grade 11 in Table 26. Similar to the data reported for Grade 10, there was no systematic trend in the data. Students with one accommodation had a mean in science of 30.10 (n = 2). The mean science score over all numbers of accommodations was 24.26 (n = 112), as compared with a mean of 39.67 (n = 7,143) for non-LEP students. Again, the lack of a systematic trend here may be due to the small cell sizes for the LEP groups, or to lack of effect of accommodations, or both.

Table 27 reports mean NCE math scores by number of accommodations for Grades 10 and 11.

Table 27

Site 3 Math NCE Means by Number of Accommodations

	Grade 10		Grade 11	
Accommodation #	*N*	Mean	*N*	Mean
Non-LEP: No accommodation	9,305	39.61	7,264	45.18
LEP: No accommodation	168	39.11	142	44.93
LEP: Any accommodation	172	34.61	135	46.01
LEP: 1 accommodation	6	30.38	2	62.50
LEP: 2 accommodations	47	39.19	46	47.88
LEP: 3 accommodations	39	36.57	15	51.26
LEP: 4 accommodations	19	26.34	3	40.23
LEP: 5 accommodation	10	28.20	22	41.77
LEP: 6 accommodations	45	33.22	37	44.06
LEP: 7 accommodations	6	37.43	10	45.46

Note. SWD students have been excluded from this analysis.

NCE means differ across the categories of number of accommodations. However, no systematic or meaningful trend can be observed. The mean was 39.61 (n = 9,305) for non-LEP students (no accommodation), and 34.61 (n = 172) for LEP students over all categories of numbers of accommodations. NCE means for Grade 11 follow patterns similar with Grade 10. There was no systematic trend in the data. Students with fewer numbers of accommodations performed better than those with higher numbers of accommodations; however, this trend may not hold over for all cases. For Grade 11, the mean for the non-LEP group was 45.18 (n = 7,264) and 46.01 for LEP students over all categories.

Table 28 and Figure 9 present SAT 9 percentile ranks at the first three quartiles for non-accommodated LEP students. As data in Table 28 show, the percentile ranks for non-accommodated LEP students were well below the NPRs in reading. The percentile ranks for science and math were also below the NPRs, but the gap between the percentile ranks of Grades 10 and 11 in Site 3 decreases as we move from reading to science and from science to math, a finding that is consistent with findings from other sites that were reported earlier. Figure 9 shows a clear picture of the performance of non-accommodated LEP students, as compared with the national performance. The content lines were all above the diagonal line, but the distance between the diagonal line and math and science was smaller than the difference between the diagonal line and reading.

Table 28

Site 3 Grades 10 and 11 Non-Accommodated LEP Percentile Ranks By SAT 9 Subsections at Cumulative Distribution Quartile

		Quartiles		
Sub-section	*N*	1st	2nd	3rd
Reading	275	9	20	38
Science	275	10	23	44
Math	275	15	36	64

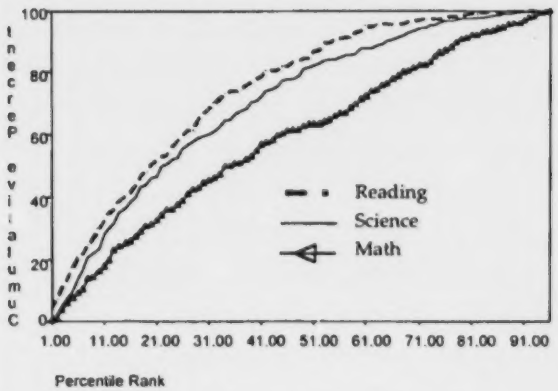

Figure 9. Site 3 Grades 10 and 11 SAT 9 CDFs for non-accommodated LEP.

Table 29 and Figure 10 compare percentile ranks of non-LEP students in reading, science, and math with the national ranks. As data in Table 29 show, the performance of non-LEP students was slightly lower than the NPRs in all three content areas, particularly in reading. However, the percentile ranks for non-LEP students were higher than those for non-accommodated LEP students (Table 28). As Figure 10 shows, the performance curves for all three content areas were above the diagonal line, but the distance between the performance curves and the diagonal line was smaller here than those for non-accommodated LEP students.

Table 29

Site 3 Grades 10 and 11 Non-LEP Percentile Ranks By SAT 9 Subsections at Cumulative Distribution Quartile

		Quartiles		
Sub-section	*N*	1st	2nd	3rd
Reading	15,648	15	30	51
Science	15,648	15	33	58
Math	15,648	15	32	59

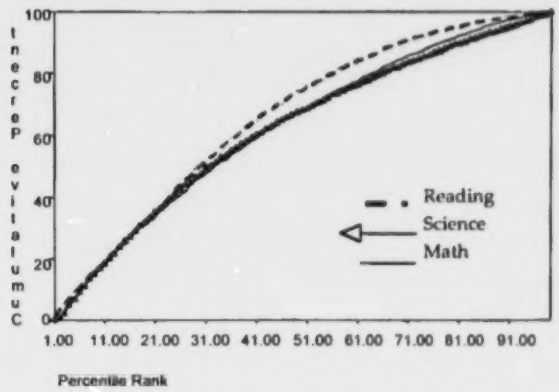

Figure 10. Site 3 Grades 10 and 11 SAT 9.

Table 30 and Figure 11 summarize the percentile rank statistics for accommodated LEP students. The difference between the percentile ranks in the three content areas (reading, science, and math) was much larger than the percentile ranks reported for both non-accommodated LEP and non-LEP students. The accommodated LEP students performed extremely poorly in reading. Their performance improved in science and further improved in math. As Figure 11 shows, the content curves for the accommodated LEP students were all well above the diagonal line, but the distance between the content curves and the diagonal line decreased as we moved from reading to science to math.

Table 30

Site 3 Grades 10 and 11 Accommodated LEP Percentile Ranks By Sat 9 Subsections at Cumulative Distribution Quartiles

		Quartiles		
Sub-section	*N*	1st	2nd	3rd
Reading	222	3	6	14
Science	222	5	11	22
Math	222	15	30	55

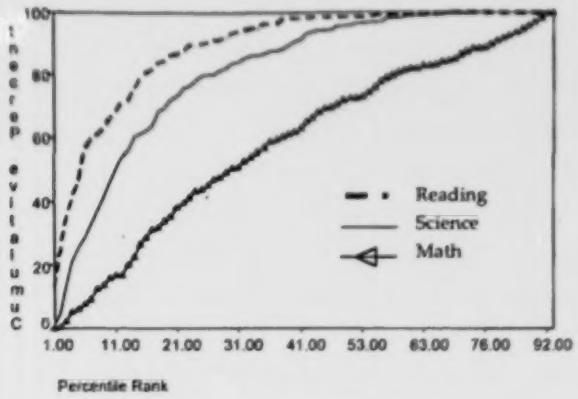

Figure 11. Site 3 Grades 10 and 11 SAT 9 CDFs for accommodated LEP students.

The results of our analyses may imply that accommodations did not help reduce the gap between LEP and non-LEP students, especially since the data show that non-accommodated LEP seem to perform better than accommodated LEP. However, as indicated earlier, we had no baseline data against which to compare accommodated assessment data. Since reading scores (which have the highest level of language demand) for accommodated LEP were substantially lower than for non-accommodated LEP, it is likely that students with low performance in reading were selected to receive an accommodation. Thus, though we still see a performance gap between accommodated and non-accommodated LEP, the performance gap could have been much larger had no accommodations been provided at all.

Site 4

Data from all school districts in a state were obtained for Grades 3, 6, 8, and 10. The data included the SAT 9 NCE scores for some of the strands (subscales). Complete data were available for a small number of the strands from the grades we obtained. Strands 1 (Total Reading) and 5 (Total Math) were available for all four grade levels. Strands 7 (Math Calculation) and 8 (Math Analytical) were available for Grades 3, 6, and 8.

To examine the impact of language on performance on content areas, we used strands that are traditionally affected by language background and those that may not be much affected by language. Since we are working with Grades 3, 6, and 8, we used the strands that were available for these three grades.

In a series of analyses, we used Strands 1 (Total Reading), 7 (Math Calculation), and 8 (Math Analytical). LEP and SWD status was used as a grouping variable, of

which four subgroups were created: (a) LEP only, (b) SWD only, (c) LEP/SWD, and (d) RFEP. Table 31 presents the number and percent of students responding to questions in reading, math calculation, and math analytical subsections of the SAT 9 by LEP and SWD categories. The percent of LEP students in Grade 3 was larger

Table 31

Site 4 Grades 3, 6, and 8 SAT 9 Frequencies

	All Students		Reading		Math calculation		Math analytical	
	N	%	*N*	%	*N*	%	*N*	%
Grade 3								
Non-LEP/non-SWD	11,014	79.8	10,785	79.8	10,975	79.9	10,957	79.9
LEP only	1,009	7.3	996	7.4	1,001	7.3	1,002	7.3
SWD only	819	5.9	782	5.8	800	5.8	796	5.8
LEP/SWD	56	0.4	54	0.4	56	0.4	54	0.4
RFEP	912	6.6	898	6.6	909	6.6	909	6.6
All students	13,810	100.0	13,151	100.0	13,741	100.0	13,718	100.0
Grade 6								
Non-LEP/non-SWD	9,890	76.1	9,840	76.2	9,846	76.2	9,855	76.2
LEP only	732	5.6	726	5.6	723	5.6	728	5.6
SWD only	1,030	7.9	1,002	7.8	1,008	7.8	1,005	7.8
LEP/SWD	81	0.6	80	0.6	81	0.6	80	0.6
RFEP	1,265	9.7	1,262	9.8	1,262	9.8	1,259	9.7
All students	12,998	100.0	12,910	100.0	12,920	100.0	12,927	100.0
Grade 8								
Non-LEP/non-SWD	9,426	76.0	9,217	76.2	9,278	76.2	9,250	76.2
LEP only	709	5.7	692	5.7	696	5.7	699	5.8
SWD only	923	7.4	872	7.2	883	7.2	873	7.2
LEP/SWD	98	0.8	93	0.8	97	0.8	94	0.8
RFEP	1,244	10.0	1,223	10.1	1,228	10.1	1,229	10.1
All students	12,400	100.0	12,097	100.0	12,182	100.0	12,145	100.0

(more than 7%) than in Grade 6 (5.6%) and in Grade 8 (5.7%). The percent of SWD was larger than the percent of LEP students for all three grades, but the number of LEP students was large enough to permit analyses by LEP and non-LEP categories.

Descriptive statistics were computed including mean, standard deviation, and number of subjects for each of these subgroups, as well as for the entire group of students. The descriptive statistics for Grade 3 are presented in Table 32.

Table 32

Site 4 Grade 3 Descriptive Statistics for the SAT 9 Test Scores by Strands

	Reading	Math	Math calculation	Math analytical
Non-LEP/non-SWD				
Mean	42.86	51.51	52.23	49.61
SD	19.61	20.81	20.89	20.66
N	10785	10922	10975	10957
LEP only				
Mean	27.94	40.94	46.25	37.36
SD	16.39	18.64	20.27	17.75
N	996	998	1001	1002
SD only				
Mean	27.14	38.21	39.80	37.58
SD	22.37	22.99	22.34	22.47
N	782	788	800	796
LEP/SD				
Mean	13.88	25.06	32.69	22.49
SD	13.31	14.57	17.89	13.98
N	54	54	56	54
RFEP				
Mean	46.05	59.44	61.76	55.08
SD	16.20	19.99	20.56	19.28
N	898	906	909	909

As the data in Table 32 show, in general, LEP/SWD students have lower scores than non-LEP/non-SWD. Also, for the entire group of students, the NCE scores were higher for math than for reading. The non-LEP/non-SWD mean NCE score for math was 51.51 (*SD* = 20.81) and for reading the mean was 42.86 (*SD* = 19.61), about an 8 score-point difference. The difference between performance in reading and math was even larger for LEP students. The mean scores for LEP were 27.94 (*SD* = 16.39) for reading and 40.94 (*SD* = 18.64) for math, with a 13 score-point difference.

In addition to reporting overall math scores in Table 32, we also reported scores for math calculation and math analytical separately. Since there is less language involved with the math calculation items, we expected LEP students to have higher scores on this type of item than on the math analytical items. And we see that the NCE score for the entire group on the math calculation strand was higher than on the math analytical strand. This difference was larger for LEP than for non-LEP students.

To compare LEP and non-LEP students, we computed a Disparity Index (DI) by subtracting the mean score of LEP students from the mean of non-LEP students, dividing the difference by the mean of LEP students, and multiplying the result by 100. Table 33 reports the DIs for reading/math and for calculation/analytical.

Through a comparison of the reading subsection DI with the DI of the math subsections (total, calculation, and analytical), we can see the impact of language on performance. The DI of non-LEP students over LEP students was lowest on the math calculation subtest. For example, for Grade 3, the DI was 53.4% in reading (non-LEP students outperformed LEP students by 55.4%), 32.8% in math analytical, as compared with a DI of 12.9% in math calculation. For Grade 8, the DIs were 125.2% for reading, 44.0% for math analytical, and 25.2% in math calculation (see Table 33).

Table 33

Disparity Index Non-LEP/Non-SWD Students Compared to LEP Only Students

	Disparity Index			
Grade	Reading	Math total	Math calculation	Math analytical
3	53.4	25.8	12.9	32.8
6	81.6	37.6	22.2	46.1
8	125.2	36.9	25.2	44.0

Table 34 presents means and standard deviations of NCE scores for students in Grade 6. The trend of the results was very similar to the trend of results reported in Grade 3. There was a large gap between the performance of LEP and non-LEP students. This gap, however, reduces with the decrease in the level of language factors. For example, the mean reading score for non-LEP/non-SWD students was 50.73 (*SD* = 18.92) as compared with a mean of 27.93 (*SD* = 14.21) with a 22.8 score-point difference (about 1.5 standard deviation). For math calculation, the difference between non-LEP/non-SWD (*M* = 52.19, *SD* = 20.60) and LEP students (*M* = 42.70, *SD* = 18.45) is only 9.48 score-points (about .5 standard deviation).

Table 34

Site 4 Grade 6 Descriptive Statistics for the SAT 9 Test Scores by Strands

	Reading	Math	Math calculation	Math analytical
Non-LEP/Non-SWD				
Mean	50.73	54.01	52.19	54.73
SD	18.92	20.08	20.60	19.84
N	9840	9807	9846	9855
LEP only				
Mean	27.93	39.26	42.70	37.46
SD	14.21	16.21	18.45	15.49
N	726	720	723	728
SWD only				
Mean	28.97	33.76	32.84	36.46
SD	18.32	16.43	17.75	16.88
N	1002	992	1008	1005
LEP/SWD				
Mean	17.92	27.93	30.91	29.02
SD	12.50	11.09	13.82	10.76
N	80	80	81	80
RFEP				
Mean	47.70	55.57	57.01	53.94
SD	16.89	19.95	20.94	19.82
N	1262	1257	1262	1259

Table 35 reports descriptive statistics for reading and math for Grade 8. These data are similar to those that were reported in Table 32 and Table 34 for Grades 3 and 6, respectively. The trend of performance for Grade 8 was very similar with those reported for Grades 3 and 6. Here again, students have a higher score on math than on reading, and LEP students show greater differences between reading and math and between math computational and math analytical.

Table 35

Site 4 Grade 8 Descriptive Statistics for the SAT 9 Test Scores by Strands

	Reading	Math	Math calculation	Math analytical
Non-LEP/Non-SWD				
Mean	45.63	49.30	49.09	48.75
SD	21.10	20.47	20.78	19.61
N	9217	91.18	9846	92.50
LEP only				
Mean	20.26	36.00	39.20	33.86
SD	16.39	18.48	21.25	16.88
N	692	687	696	699
SWD only				
Mean	18.86	27.82	28.42	29.10
SD	19.70	14.10	15.76	15.14
N	872	843	883	873
LEP/SWD				
Mean	9.78	21.37	22.75	22.87
SD	11.50	10.75	12.94	12.06
N	93	92	97	94
RFEP				
Mean	41.33	51.04	52.57	48.84
SD	19.59	21.63	21.92	20.19
N	12.23	12.09	12.28	12.29

Table 36 and Figure 12 present percentile ranks data for English only (EO) students with low SES in reading, math application and math computation. The data in Table 36 show that EO/low SES students perform poorly in reading. Their performance improves in math (application and computation). Figure 12 presents a clear picture of this trend. The content curve for reading was well above the diagonal line, suggesting poor performance in this content area. The math content curves were closer to the diagonal line.

Table 36

Site 4 Grade 8 SAT 9 Percentile Ranks for EO/low SES at Cumulative Distribution Quartiles by Subsection

		Quartiles		
Sub-test	*N*	1st	2nd	3rd
Reading	3,455	9	26	49
Math application	3,455	16	29	54
Math computation	3,455	15	29	55

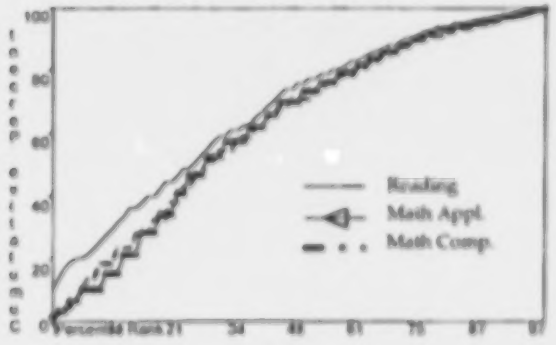

Figure 12. Site 4 Grade 8 SAT 9 CDFs for EO/low SES.

Table 37 and Figure 13 present percentile rank information for EO/higher SES students similar to that presented in Table 36 for EO/low SES students. Students performed near the national level in all three subject areas (reading, math application, and math computation), with reading percentiles being slightly lower than the NPRs. No major differences were found between reading and math. These findings suggest that the language factors have more critical impact on students with low English language proficiency and low SES.

Table 37

Site 4 Grade 8 SAT 9 Percentile Ranks for EO/higher SES at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Sub-test	*N*	1st	2nd	3rd
Reading	6,317	24	47	72
Math application	6,317	25	50	75
Math computation	6,317	26	48	77

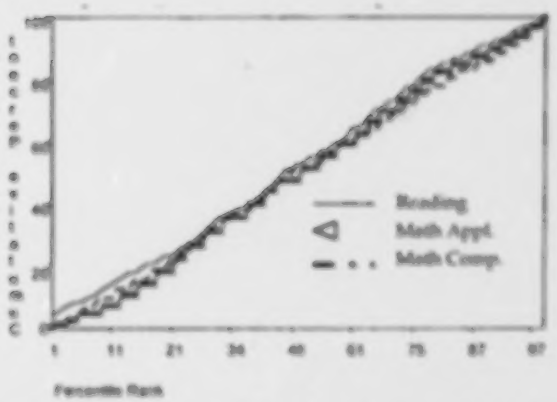

Figure 13. Site 4 Grade 8 SAT 9 CDFs for EO/higher SES.

Table 38 and Figure 14 present percentile rank results for LEP students. Comparing these data with the data for non-LEP students suggests, once again, that LEP students perform substantially lower than non-LEP students in subject areas with a higher level of language demand. As Figure 14 shows, the content curve for reading was well above the diagonal line (national performance). The content curves for math application and math computation were also above the diagonal line, but the distance was much smaller than the reading curve distance.

Descriptive statistics for SES status in Site 4 will be presented in more detail in the multivariate section of this report. The interaction between LEP status and SES will also be analyzed.

Table 38

Site 4 Grade 8 SAT 9 Percentile Ranks for LEP Students at Cumulative Distribution Quartiles, by Subsection

		Quartiles		
Sub-test	*N*	1st	2nd	3rd
Reading	767	1	7	17
Math application	767	10	19	33
Math computation	767	9	21	52

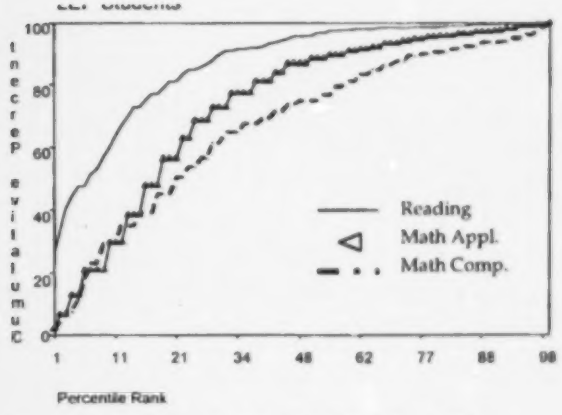

Figure 14. Site 4 Grade 8 SAT 9 CDFs for LEP students.

Item-Level Analyses

To estimate reliability of the standardized achievement tests used in this study, we considered different approaches. Since parallel forms or test-retest data were not available, we decided to use an internal consistency approach. The main problem with the internal consistency approach, however, is the assumption of unidimensionality. The literature has suggested that Cronbach's alpha, which is a measure of internal consistency, is extremely sensitive to multi-dimensionality of test items (see, for example, Abedi, Lord, & Hofstetter, 1997; Cortina, 1993). However, because the test items within each content area are supposed to measure the same construct, we believe this approach may be appropriate for estimating reliability of the achievement tests used in this study.

Based on the analyses of data from other sites, we suggested earlier that the language load of the test items might introduce a bias into the assessment. That is, a language factor may act as a source of measurement error in the assessment of LEP students. To examine the hypothesis of the impact of language on assessment, we performed a principal components analysis on the item-level data and computed internal consistency coefficients (coefficient alpha) by bilingual status (for issues concerning factoring phi-coefficient, see Abedi, 1997). We also compared the performance of LEP with non-LEP students at the item-level to examine the possible differential functioning of each item across the LEP categories.

Because different data sites used different tests and, within the individual sites, different test forms were used in different grades, these analyses were performed separately for each site and each grade. Within each grade, we conducted the internal consistency analyses separately for bilingual and non-bilingual students so that we could compare the subtest internal consistencies for the bilingual and non-bilingual groups. We will report the findings of this part of our study for each site separately.

Site 1

Internal consistency of test items by student language status. Site 1 did not have information on LEP status, but instead provided information on bilingual status. Students were categorized as either bilingual or non-bilingual. While the

bilingual status of students may be different with their LEP status, we used this information as a proxy for LEP status.

Table 39 summarizes the results of the principal components and internal consistency analyses for math (problem solving, concepts, estimation, data interpretation, and computation subsections) and reading. For each of the six subsections, more than one component with eigenvalue greater than one was extracted. Across the subsections, the number of components (factors) with eigenvalue greater than one ranged from 2 through 8. The percent of common variance explained by the first component was below 26% of the total item variance for each subsection at each grade. If the items in a subtest were all measuring the same construct, then we would have expected a higher proportion of common variance for the first principal component. These results may suggest low internal consistency among the test items in the math and reading subsections, particularly for the bilingual subgroup.

To examine the pattern of item internal consistency among bilingual and non-bilingual students, we computed coefficient alphas separately for the two groups of students. As the results in Table 39 show, the item responses of bilingual students in general show lower internal consistency. The gap between the internal consistency coefficients of the two groups varied across grade and test subsection. Consistent with our findings reported earlier, the differences between the bilingual and non-bilingual groups were small for Grade 3. For higher grades, this gap increased. For example, in Grade 3, the average alpha coefficient (across the six subtests) was .74 for bilingual students and .76 for non-bilingual students. In Grade 6, the average was .71 for bilingual students and .84 for non-bilingual students. In Grade 8, the average was .74 for bilingual students and .83 for non-bilingual students. This trend may occur because the test items for Grade 3 may be less linguistically complex than the items for the higher grades.

Table 39

Site 1 Summary Results of Principal Components and Reliability Analyses

Subsection/Grade	Number of components eigenvalue>1	Percent of variance of 1st component	Reliability (α) bilingual	Reliability (α) non-bilingual
Math problem solving				
Grade 3	2	22.88	.74	.70
Grade 6	2	20.68	.64	.77
Grade 8	3	16.84	.60	.71
Math concepts				
Grade 3	2	17.43	.72	.74
Grade 6	4	17.01	.66	.82
Grade 8	4	16.49	.75	.83
Math estimation				
Grade 3	2	24.99	.69	.70
Grade 6	3	17.89	.65	.73
Grade 8	5	13.80	.63	.68
Math data interpretation				
Grade 3	2	25.25	.60	.66
Grade 6	2	20.16	.51	.69
Grade 8	3	15.86	.48	.64
Math computation				
Grade 3	5	23.31	.89	.90
Grade 6	7	20.91	.87	.90
Grade 8	7	20.25	.88	.90
Reading				
Grade 3	6	16.77	.82	.85
Grade 6	5	16.64	.65	.88
Grade 8	9	14.67	.72	.87

It is also clear from the results shown in Table 39 that the gap between internal consistency (alpha) coefficients for bilingual and non-bilingual students varied across the content areas. Internal consistency coefficients for subsections with more language load were substantially lower for bilingual students. For example, on the reading subsection in Grades 6 and 8 the average alpha was .68 for bilingual students, compared with .88 for non-bilingual students. However, on the math computation subsection, which has less language demand, there was a

correspondingly smaller difference between the alphas for bilingual (.88) and non-bilingual (.90) students.

Figure 15 compares the internal consistency coefficients for bilingual and non-bilingual students across the four different content areas for Grade 3. The differences between the bilingual and non-bilingual alphas were very small and, in some cases, non-existent.

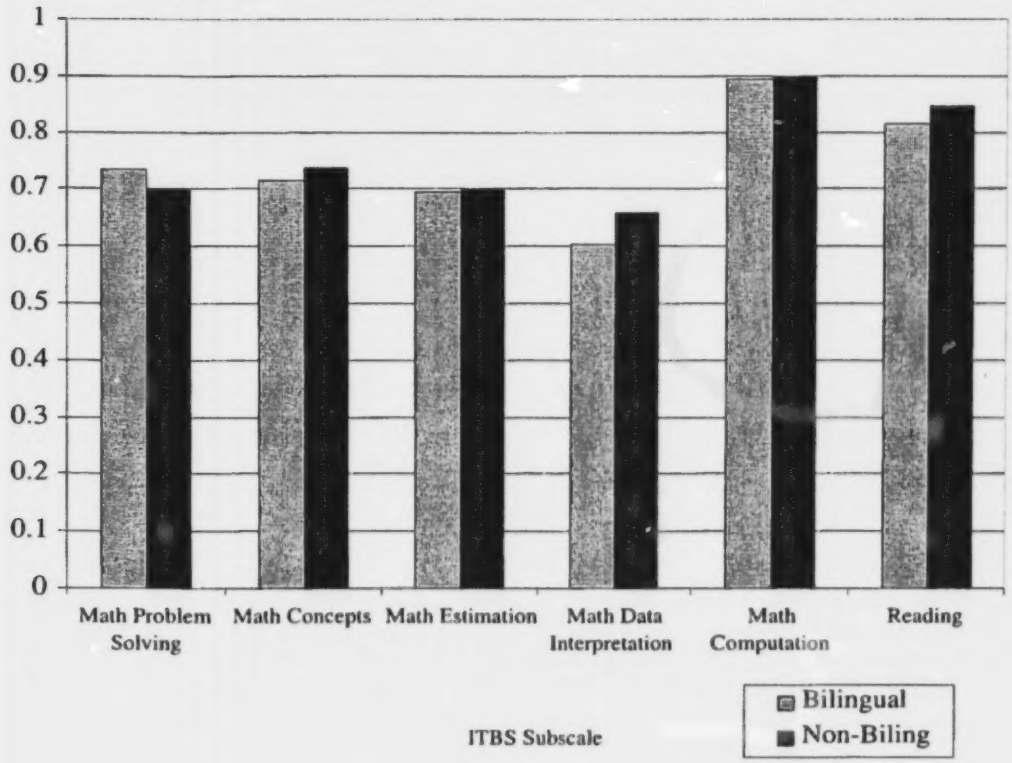

Figure 15. Site 1 Grade 3 reliability alphas.

Figure 16 and Figure 17 present the results of analyses for Grades 6 and 8, respectively. As indicated earlier, the differences in alpha coefficients between bilingual and non-bilingual students in Grades 6 and 8 were substantially larger than the differences in Grade 3. The largest differences between bilingual and non-

bilingual students occur in reading, where the language load is greatest. In math computation, where the language load is smallest, the alpha differences were the smallest.

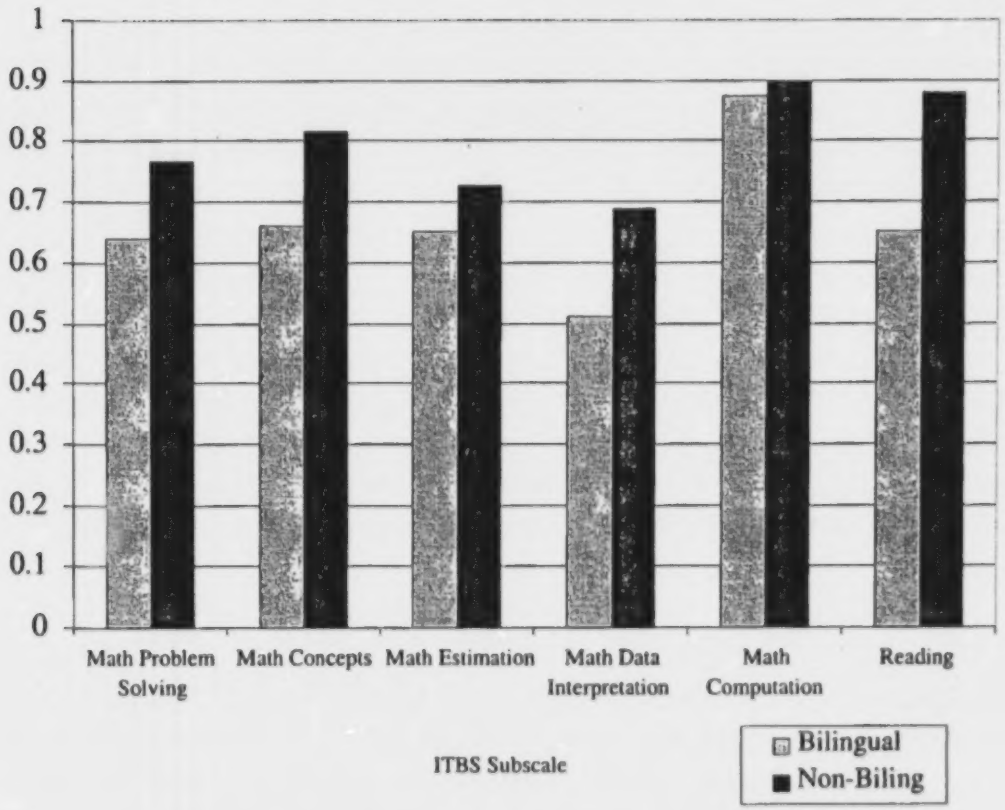

Figure 16. Site 1 Grade 6 reliability alphas.

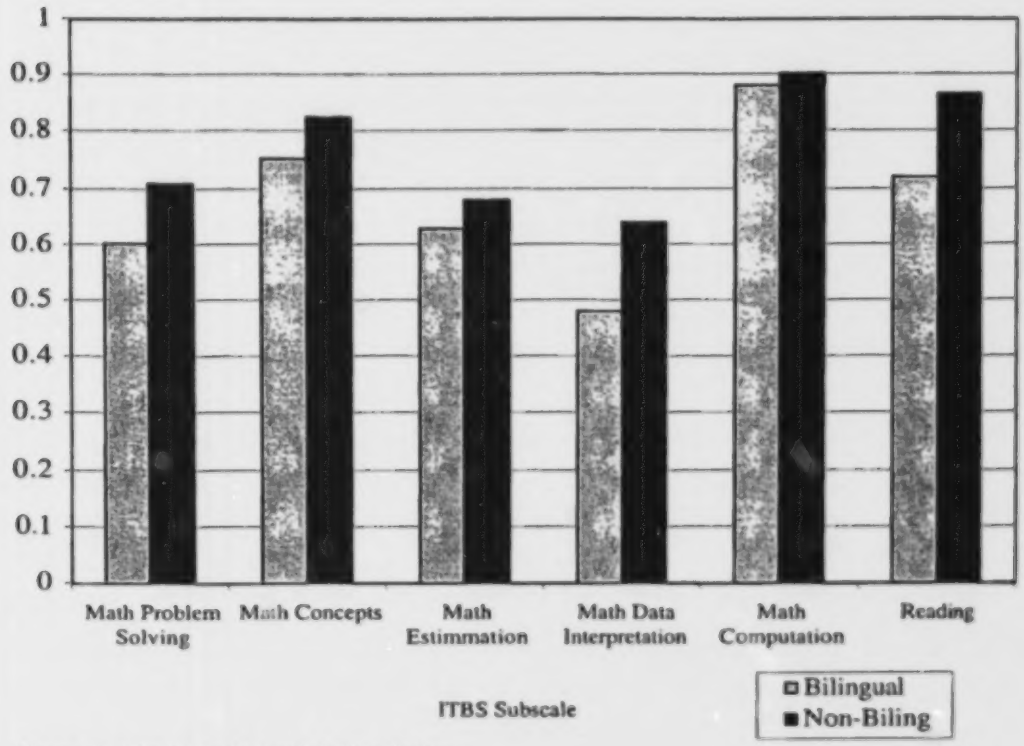

Figure 17. Site 1 Grade 8 reliability alphas.

The lower reliability (internal consistency) may have been caused by restriction of range in the bilingual population. It is plausible that the restriction of range in the bilingual group was an effect of language and other factors, such as SES and opportunity to learn (OTL). We used the Grade 8 reading and math computation subtests to illustrate the possible impact of restriction of range. In the high language demand reading content area, there was a large difference in the reliabilities for the bilingual and non-bilingual groups, with alphas of .722 and .869, respectively. There was also a large difference in the reading raw score[7] variances for the two groups, 32.73 and 62.04, resulting in a significant restriction of range in the bilingual group. Figure 18 and Table 40 show the bilingual and non-bilingual reading raw score distributions for the two groups along with the variances and alpha reliabilities. The bilingual distribution had less spread and was centered lower than the non-bilingual distribution. In stark contrast, in the low language demand math computation area, there was a small difference in the internal consistency reliabilities for the two

[7]Here we used raw scores rather than NCEs because Cronbach's alpha utilizes raw score variance.

groups, and the raw score variances were similar in magnitude. Figure 19 and Table 41 show the math computation distributions, variances, and alphas for the two groups. The distributions were quite similar for the two groups.

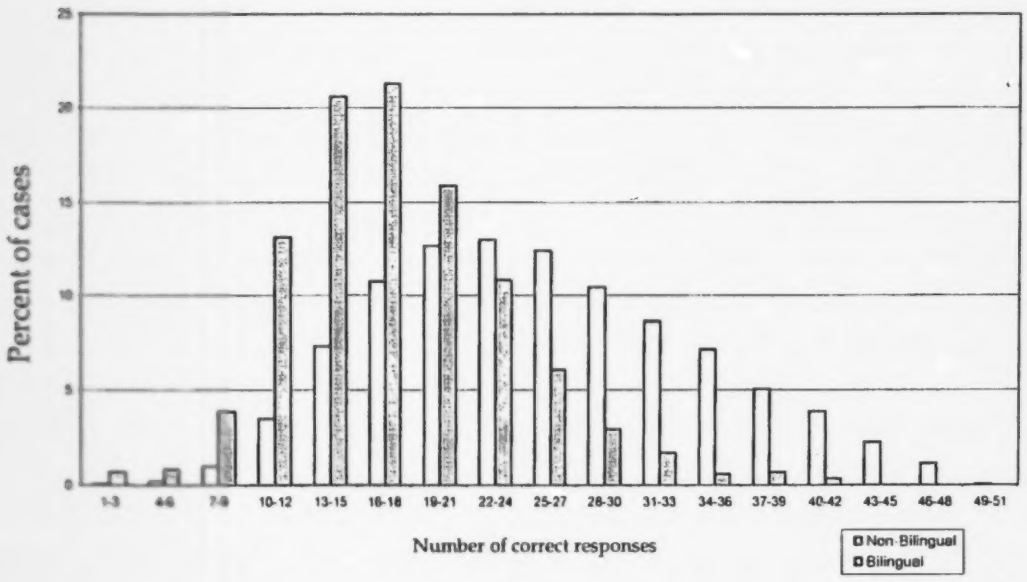

Figure 18. Site 1 Grade 8 reading distributions and reliability.

Table 40

Site 1 Grade 8 Reading Distributions and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Non-bilingual	25.60	75.14	.869
Bilingual	17.76	36.65	.722

We believe that language (and perhaps other factors, such as SES and OTL) causes a restricted range distribution, a distribution of scores with lower variability, and this in turn causes lower internal consistency.

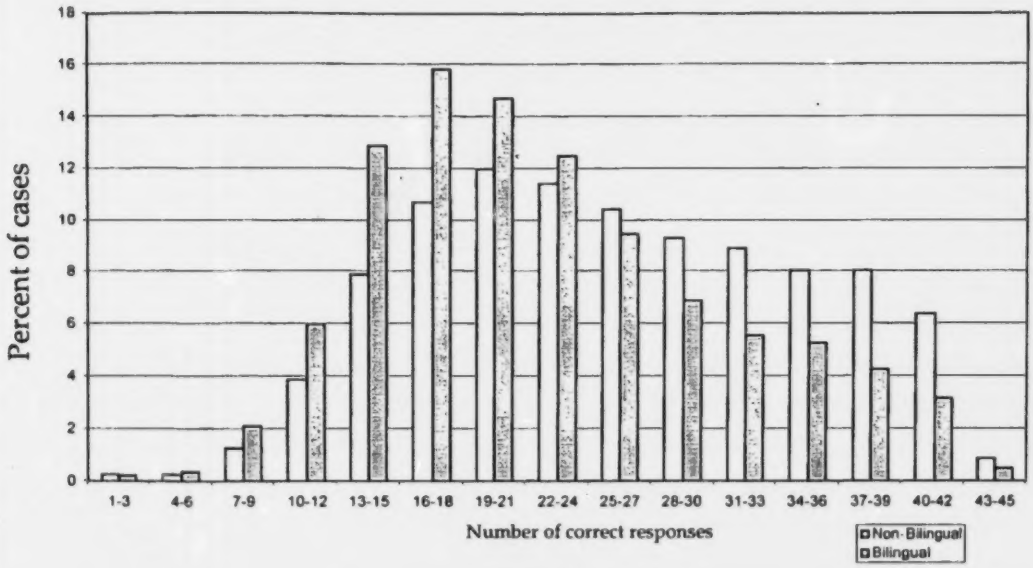

Figure 19. Site 1 Grade 8 math computation distributions and reliability.

Table 41

Site 1 Grade 8 Math Computation Distributions and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Non-bilingual	25.80	79.24	.904
Bilingual	22.49	69.09	.884

Another factor that could affect the size of alpha (the internal consistency coefficient) is the number of test items. Because the number of items varied across the subsections, the internal consistency coefficients may differ in size. To control for differences in alpha due to differences in the number of items, we adjusted the internal consistency coefficients by the number of items. The subsection with the maximum number of items was the reading subsection for Grade 8, with 49 items. We thus adjusted the alpha coefficients to reflect a constant length of 49 items for each subsection. Table 42 presents the unadjusted and adjusted alpha coefficients. By increasing the number of items, the internal consistency coefficients increased substantially in some cases. However, the general trend of lower internal consistency coefficients for the bilingual students remained.

Table 42

Site 1 Internal Consistency Coefficients Adjusted by the Number of Items

Subsection/Grade	Unadjusted		Adjusted	
	Reliability (α) bilingual	Reliability (α) non-bilingual	Reliability (α) bilingual	Reliability (α) non-bilingual
Math problem solving				
Grade 3 (14 items)	.74	.70	.91	.89
Grade 6 (18 items)	.64	.77	.83	.90
Grade 8 (20 items)	.60	.71	.79	.86
Math concepts				
Grade 3 (20 items)	.72	.74	.86	.87
Grade 6 (28 items)	.66	.82	.77	.89
Grade 8 (32 items)	.75	.83	.82	.88
Math estimation				
Grade 3 (12 items)	.69	.70	.90	.91
Grade 6 (20 items)	.65	.73	.82	.87
Grade 8 (24 items)	.63	.68	.78	.81
Math data interpretation				
Grade 3 (10 items)	.60	.66	.88	.91
Grade 6 (14 items)	.51	.69	.79	.89
Grade 8 (16 items)	.48	.64	.74	.84
Math computation				
Grade 3 (34 items)	.89	.90	.92	.93
Grade 6 (41 items)	.87	.89	.89	.91
Grade 8 (43 items)	.88	.90	.90	.91
Reading				
Grade 3 (36 items)	.82	.85	.86	.88
Grade 6 (44 items)	.65	.88	.68	.89
Grade 6 (44 items)	.72	.87	.72	.87

The results presented so far demonstrate that bilingual students do not perform as well as non-bilingual students, especially in content areas with higher language demand. Results of analyses on individual test items were consistent with this general trend. That is, in most of the cases, item scores for the bilingual students were lower than the item scores for non-bilingual students. However, the item-level differences between bilingual and non-bilingual students varied greatly across the test items. Some of the test items were more difficult for the bilingual students than

other items, and items may function differently with different groups. We speculate that items with more complex language would be more difficult for bilingual students, regardless of the level of content difficulty.

We computed the difference between the mean score for each individual item across the bilingual categories by subtracting the mean score for bilingual students from the mean score for non-bilingual students. We called this difference "Difference between Bilingual and Non-bilingual students" (DBN). Because all ITBS items were in multiple-choice format, DBN was the difference between the proportion of correct responses for bilingual and non-bilingual students. A negative DBN indicates that bilingual students had higher performance than their non-bilingual peers on that particular item. Due to space limitations, we did not include the results of this analysis in our report. However, we summarize the results of item-level DBN in Table 43. We rank ordered the items based on the magnitude of DBN and present the minimum, maximum, and average DBN for each ITBS subsection.

As the results indicate, the range and average of DBN vary across the grade levels and content areas. For Grade 3, the average DBN was small on all subtests, except reading. The average DBN in the math computation subtest was negative, indicating that bilingual students performed slightly better than non-bilingual students. This was consistent with our earlier Grade 3 findings that there was a minimal performance gap between bilingual and non-bilingual students. For Grades 6 and 8, the DBN was larger in content areas with more language demand. The maximum difference between the proportion of correct responses of bilingual and non-bilingual students was .29 for Grade 6 and .38 for Grade 8 reading.

Table 43

Site 1 Item-Level Response Differences Between Bilingual and Non-Bilingual Students (DBN)

Subsection/Grade	# of items	Minimum	Maximum	Average DBN
Math problem solving				
Grade 3	14	.01	.07	.04
Grade 6	18	.01	.19	.12
Grade 8	20	.03	.26	.12
Math concepts				
Grade 3	20	-.02	.08	.01
Grade 6	28	-.01	.25	.09
Grade 8	32	-.01	.21	.12
Math estimation				
Grade 3	12	.00	.03	.01
Grade 6	20	.00	.14	.09
Grade 8	24	-.02	.16	.08
Math data interpretation				
Grade 3	10	-.03	.09	.04
Grade 6	14	.01	.25	.08
Grade 8	16	.05	.28	.11
Math computation				
Grade 3	34	-.05	.01	-.02
Grade 6	41	-.02	.15	.04
Grade 8	43	.01	.17	.07
Reading				
Grade 3	36	-.04	.17	.08
Grade 6	44	.02	.29	.15
Grade 8	49	.03	.38	.15

As expected, on items with less language demand, the size of DBN was substantially smaller than the DBN presented for the reading subsections. For example, on the math computation subsection the maximum DBNs for Grades 6 and 8 were .15 and .17, while on the reading subsection the maximum differences for Grades 6 and 8 were .29 and .38, respectively.

Site 2

Site 2 is an entire state with a large LEP population. This site provided data on SAT 9 for all students in all elementary schools, middle schools, and high schools for the entire state, along with information on bilingual status and other background variables. Table 44 presents reliability (internal consistency) coefficients for the SAT 9 data for Grade 2. Consistent with the data presented earlier for lower grades, there was only a slight difference between the alpha coefficients across the LEP categories. Non-LEP students had slightly higher coefficients than the LEP students. There was also a slight difference between the alpha coefficients across the SES categories. Higher SES students had slightly higher alphas than low SES students. For example, the average reliability for reading subscale for the higher SES group was .913, as compared with an average reliability of .893 for the low SES group. The average reliability for non-LEP was .914, as compared with an average reliability of .856 for LEP students.

As the data in Table 44 show, the difference between reliability coefficients of LEP and non-LEP was larger than the difference between reliability coefficients of high and low SES.

Table 44

Site 2 Grade 2 SAT 9 Sub-Scale Reliabilities (1998), Unadjusted Alphas

	Non-LEP students					
Sub-scale (# items)	Higher SES	Low SES	EO	FEP	RFEP	LEP
Reading	N = 209,262	N = 58,485	N = 234,505	N = 29,771	N = 3,471	N = 101,399
Word Study (48)	.917	.895	.916	.915	.920	.865
Vocabulary (30)	.913	.897	.915	.906	.907	.857
Reading Comp. (30)	.908	.888	.910	.900	.899	.846
Average reliability	.913	.893	.914	.907	.909	.856
Math	N = 220,971	N = 63,146	N = 249,000	N = 31,444	N = 3,673	N = 118,740
Problem Solving (45)	.893	.881	.896	.886	.890	.871
Procedures (28)	.892	.892	.891	.887	.895	.890
Average reliability	.893	.887	.894	.887	.893	.881
Language	N = 218,003	N = 62,028	N = 245,384	N = 31,035	N = 3,612	N = 111,752
Total (44)	.890	.866	.891	.883	.892	.829

Since the number of test items affects test reliability, we adjusted the reliability coefficients based on the number of test items. Table 45 presents reliability coefficients based on the assumption that all subscales have the same number of items. The trend that was observed between the higher and low SES groups, and between LEP and non-LEP students, before adjusting by the number of items holds in the adjusted reliability coefficients. In this table, reliability coefficients for higher SES students were lower than the coefficients for low SES students and the reliability coefficients for non-LEP students were higher than those for LEP students.

Table 45

Site 2 Grade 2 Content Area NCEs and Sub-Scale Reliability Adjusted Alphas Based on 54 Items

	Non-LEP students					
Sub-scale (# items)	Higher SES	Low SES	EO	FEP	RFEP	LEP
Reading	NCE = 50.9	NCE = 40.0	NCE = 48.6	NCE = 48.5	NCE = 47.5	NCE = 31.4
Word study (48)	.926	.906	.925	.924	.928	.878
Vocabulary (30)	.950	.940	.951	.946	.946	.915
Reading comp. (30)	.947	.935	.948	.942	.941	.908
Average reliability	.941	.927	.941	.937	.938	.900
Math	NCE = 51.9	NCE = 41.1	NCE = 49.3	NCE = 50.7	NCE = 51.2	NCE = 37.2
Problem solving (45)	.909	.899	.912	.903	.907	.890
Procedures (28)	.941	.941	.940	.938	.943	.940
Average reliability	.925	.920	.926	.921	.925	.915
Language	NCE = 52.6	NCE = 40.0	NCE = 49.9	NCE = 49.5	NCE = 48.4	NCE = 31.3
Total (44)	.909	.888	.909	.903	.910	.856

Table 46 presents unadjusted reliability (internal consistency) coefficients for Grade 7. Comparing the internal consistency coefficients for Grade 7 with those for Grade 3 (reported in Table 44 and Table 45) reveals interesting trends. In general, the reliability coefficients for LEP students were lower than the coefficients for non-LEP students. We indicated earlier that this might be due to the impact of language factors as a source of measurement error. This trend of lower reliability for LEP students can be seen for both Grades 3 and 7. However, in Grade 7, the difference between reliability coefficients for LEP and non-LEP was larger. For example, the difference between reliability coefficients for LEP and non-LEP in Grade 3 was .058 in reading, .013 in math, and .062 in language, as compared with the LEP and non-LEP reliability difference of .078 for reading, .093 for math, and .109 for language in Grade 7. As these results suggest, the difference between reliability coefficients for LEP and non-LEP students was larger for Grade 7 when compared with Grade 3. This difference was even larger for Grade 9. The difference between reliability coefficients for LEP and non-LEP for Grade 9 was .126 in reading, .096 in math, and .130 in language, as compared with the respective differences of .058 in reading, .013 in math, and .062 in language for Grade 3.

Table 46

Site 2 Grade 7 SAT 9 Sub-Scale Reliabilities (1998), Unadjusted Alphas

	Non-LEP					
Sub-scale (# items)	Higher SES	Low SES	EO	FEP	RFEP	LEP
Reading	*N* = 210,325	*N* = 56,910	*N* = 207,017	*N* = 34,730	*N* = 25,488	*N* = 99,074
Vocabulary (30)	.852	.835	.862	.849	.811	.755
Reading comp. (54)	.914	.906	.919	.910	.886	.870
Average reliability	.883	.871	.891	.880	.849	.813
Math	*N* = 211,396	*N* = 57,471	*N* = 208,363	*N* = 34,913	*N* = 25,591	*N* = 71,277
Problem solving (50)	.907	.867	.907	.909	.888	.806
Procedures (30)	.891	.850	.888	.896	.877	.803
Average reliability	.899	.859	.898	.903	.883	.805
Language	*N* = 208,896	*N* = 56,567	*N* = 205,734	*N* = 34,424	*N* = 25,305	*N* = 69,364
Mechanics (24)	.811	.779	.819	.804	.751	.723
Expression (24)	.824	.798	.832	.816	.771	.710
Average reliability	.818	.789	.826	.810	.761	.717

Table 47 presents adjusted reliability coefficients for Grade 7. By increasing the number of items in a test, reliability coefficients increased for both LEP and non-LEP groups but the trend of differences between LEP and non-LEP remained the same with the unadjusted coefficients. That is, increasing the number of items reduced the performance gap between LEP and non-LEP students slightly, but the reduction in performance gap was not large enough to be noticeable.

Table 47

Site 2 Grade 7 Content Area NCEs and Sub-Scale Reliability Adjusted Alphas Based on 54 Items

	Non-LEP					
Sub-scale (# items)	Higher SES	Low SES	EO	FEP	RFEP	LEP
Reading	NCE = 52.3	NCE = 40.2	NCE = 50.3	NCE = 48.5	NCE = 46.1	NCE = 25.2
Vocabulary	.912	.901	.918	.910	.885	.847
Reading comp.	.914	.906	.919	.910	.886	.870
Average reliability	.913	.904	.919	.910	.886	.859
Math	NCE = 52.6	NCE = 41.5	NCE = 50.0	NCE = 51.5	NCE = 50.0	NCE = 33.6
Problem solving	.913	.876	.913	.915	.895	.818
Procedures	.936	.911	.935	.939	.928	.880
Average reliability	.925	.894	.924	.927	.912	.849
Language	NCE = 55.4	NCE = 44.1	NCE = 53.1	NCE = 53.4	NCE = 51.9	NCE = 31.2
Mechanics	.906	.888	.911	.902	.872	.854
Expression	.913	.899	.918	.909	.883	.846
Average reliability	.910	.899	.915	.906	.878	.850

Table 48 presents the unadjusted reliability coefficients for Grade 9. Comparing these with Grade 3 (reported in Table 44 and Table 45) again revealed that reliability coefficients for LEP students were lower than the coefficients for non-LEP students. Once again, this could be due to the impact of language factors as a source of measurement error. In both Grades 3 and 9, reliabilities were lower for LEP students. However, in Grade 9, the difference between reliability coefficients for LEP and non-LEP was larger. For example, the difference between reliability coefficients for LEP and non-LEP was .058 in reading, .013 in math, and .062 in language in Grade 3, as compared with the LEP and non-LEP reliability difference of .109 for reading, .096 for math, and .120 for language in Grade 9. These differences for Grade 9 were even higher than the differences for Grade 7. Thus, the reliability gap between LEP and non-LEP increases as grade level increases. This may be due to the use of more complex language structures in higher grades.

Table 48

Site 2 Grade 9 SAT 9 Sub-Scale Reliabilities (1998), Unadjusted Alphas

	Non-LEP					
Sub-scale (# items)	Higher SES	Low SES	EO	FEP	RFEP	LEP
Reading	*N* = 205,092	*N* = 35,855	*N* = 181,202	*N* = 37,876	*N* = 21,869	*N* = 52,720
Vocabulary (30)	.828	.781	.835	.814	.759	.666
Reading comp. (54)	.912	.892	.916	.903	.877	.833
Average reliability	.870	.837	.876	.859	.818	.750
Math	*N* = 207,155	*N* = 36,588	*N* = 183,262	*N* = 38,329	*N* = 22,152	*N* = 54,815
Total (48)	.899	.853	.898	.898	.876	.802
Language	*N* = 204,571	*N* = 35,886	*N* = 180,743	*N* = 37,862	*N* = 21,852	*N* = 52,863
Mechanics (24)	.801	.759	.803	.802	.755	.686
Expression (24)	.818	.779	.823	.804	.757	.680
Average reliability	.810	.769	.813	.803	.756	.683
Science	*N* = 163,960	*N* = 28,377	*N* = 144,821	*N* = 29,946	*N* = 17,570	*N* = 40,255
Total (40)	.800	.723	.805	.778	.716	.597
Social science	*N* = 204,965	*N* = 36,132	*N* = 181,078	*N* = 38,052	*N* = 21,967	*N* = 53,925
Total (40)	.803	.702	.805	.784	.722	.530

Table 49 presents the adjusted reliability coefficients for Grade 9. A similar trend of higher reliability coefficients for non-LEP students was also evident. However, as was the case for Grade 7, the reliability difference between LEP and non-LEP students decreases slightly by increasing the number of items.

Table 49

Site 2 Grade 9 Content Area NCEs and Sub-Scale Reliability Adjusted Alphas Based on 54 Items

	Non-LEP					
Sub-scale (# items)	Higher SES	Low SES	EO	FEP	RFEP	LEP
Reading	NCE = 45.9	NCE = 36.6	NCE = 45.5	NCE = 42.4	NCE = 40.1	NCE = 23.4
Vocabulary	.897	.865	.901	.887	.850	.782
Reading comp.	.912	.892	.916	.903	.877	.833
Average reliability	.905	.879	.909	.895	.864	.808
Math	NCE = 53.4	NCE = 45.2	NCE = 52.4	NCE = 51.9	NCE = 50.7	NCE = 37.5
Total	.909	.867	.908	.908	.888	.820
Language	NCE = 52.0	NCE = 44.8	NCE = 51.1	NCE = 50.9	NCE = 49.9	NCE = 34.1
Mechanics	.901	.876	.902	.901	.874	.831
Expression	.910	.888	.913	.902	.875	.827
Average reliability	.906	.882	.908	.902	.875	.829
Science	NCE = 49.3	NCE = 42.1	NCE = 48.9	NCE = 46.6	NCE = 45.3	NCE = 34.5
Total	.844	.779	.848	.826	.773	.667
Social science	NCE = 49.3	NCE = 42.1	NCE = 48.7	NCE = 47.2	NCE = 45.9	NCE = 34.2
Total	.846	.761	.848	.831	.778	.604

Internal consistency of test items by student language status. The results of internal consistency analyses that were reported earlier clearly demonstrated that LEP student responses to test items suffer from lower internal consistency as compared with non-LEP students. These results may lead us to believe that language factors may be responsible for the lower internal consistency for LEP students. However, the results of multiple regression and canonical correlation analyses suggests that factors other than language may also contribute to the gap between internal consistency of the two groups of students. For example, the results of multiple regression analyses showed that ethnicity was the strongest predictor among a set of variables (gender, reading, and math scores) in predicting LEP status.

The results of canonical analyses also helped us to understand confounding of LEP status with other background variables. The results of canonical correlation analyses indicated that parent education was one of the strongest associates of LEP

status. In this model, SES also showed a strong relationship with LEP status. However, a main factor affecting the internal consistency coefficient (alpha coefficient) was the distribution of scores. Restriction of range in the distribution of scores may have substantial impact on the alpha and may cause it to be underestimated. To present a clear picture of the restriction of range issue, we also presented the distribution of scores for subgroups of students that were formed based on some background variables.

We will first discuss the results of our internal consistency analyses and will then talk about the effect of score distributions on alpha coefficients.

We categorized all students into three mutually exclusive categories. Non-LEP students were categorized as either higher or low SES. The third category was comprised of LEP students. We then computed alpha coefficients for these three subgroups. If LEP status is mainly determined by SES, and if LEP students are mainly from low SES categories, then the scores distributions, as well as alpha coefficients, computed for low SES categories should be similar with those computed for LEP students.

We computed alpha coefficients for Grades 2, 7, 9, and 11 in Site 2. The trend of results was very similar across the different grades. Due to space limitations, we will only report the results for Grade 7.

The table at the bottom of Figure 20 presents alpha coefficients for reading comprehension for Grade 7. As the table shows, the alpha coefficient for the higher SES group was .906, as compared with the alpha of .902 for the low SES group, a minor difference. The coefficient for the LEP group, however, was lower (alpha = .870) than the coefficient for the low SES group (alpha = .902). The variances for the higher SES group (104.49) and for the low SES group (109.19) were similar, but the LEP group has smaller variance (86.40). Thus, the lower reliability for the LEP group may be due to restriction of range. However, restriction of range may have been the result of language factors because language may have limited the level of ability to respond to the test items.

Figure 20 and Table 50 present the distribution of reading comprehension scores for the three groups (higher SES, low SES, and LEP). LEP students had a positively skewed distribution. However, distributions for high and low SES students were negatively skewed. The distributions for the higher SES and LEP groups are skewed to a relatively similar degree, but in different directions.

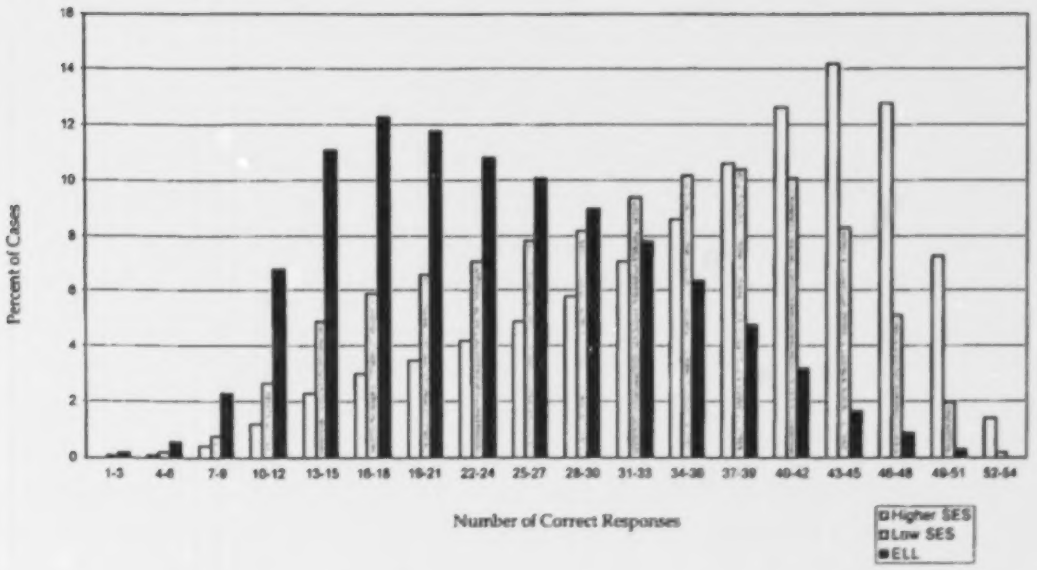

Figure 20. Site 2 Grade 7 reading comprehension distributions and reliability.

Table 50

Site 2 Grade 7 Reading Comprehension Distributions and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Higher SES	36.74	104.49	.906
Low SES	31.26	109.19	.902
LEP	23.85	86.40	.870

Figure 21 and Table 51 present the results for language scores for Grade 7. The trend of results for the language subsection was similar across the three content areas to what was just described for the reading comprehension subsection. Alpha coefficients for the higher and low SES groups were relatively similar to each other and were different from the alpha coefficients for the LEP group.

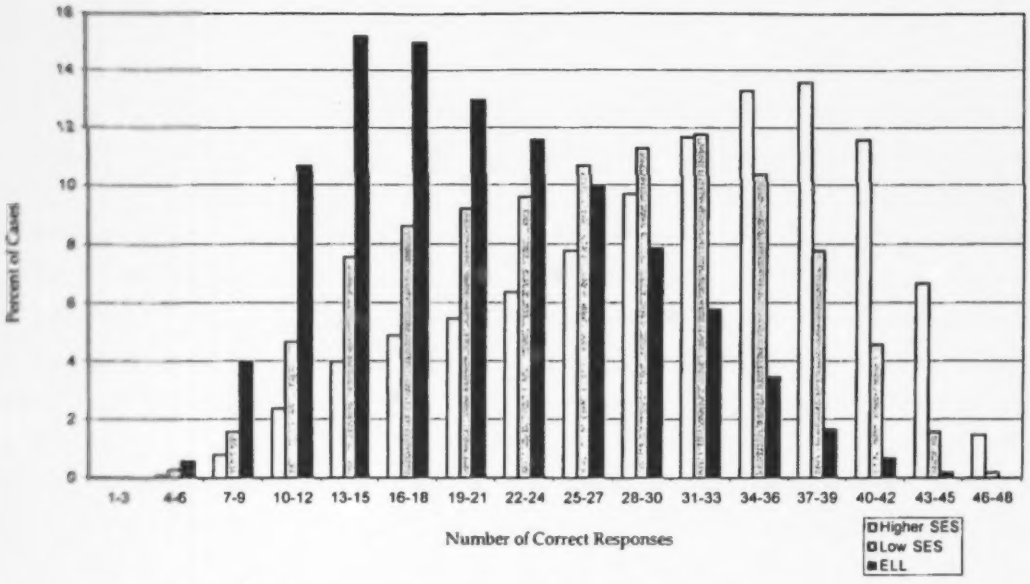

Figure 21. Site 2 Grade 7 language distribution and reliability.

Table 51

Site 2 Grade 7 Language Distribution and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Higher SES	31.15	83.69	.868
Low SES	26.35	79.69	.847
LEP	20.49	59.56	.803

Figure 22 and Table 52 present results for social science scores for Grade 7. For social science, more difference can be seen between the alphas for the higher (.837) and low (.767) SES groups than had been seen in the reading and language subsections, but there was also a much larger difference between LEP students (.605) and non-LEP students. On the reading and language subsections, the distributions for the higher SES and LEP groups showed a relatively similar degree of skewness, but in different directions. However, the distribution across SES and LEP categories for the social science subsection showed a large difference in the degree of skewness in the same direction.

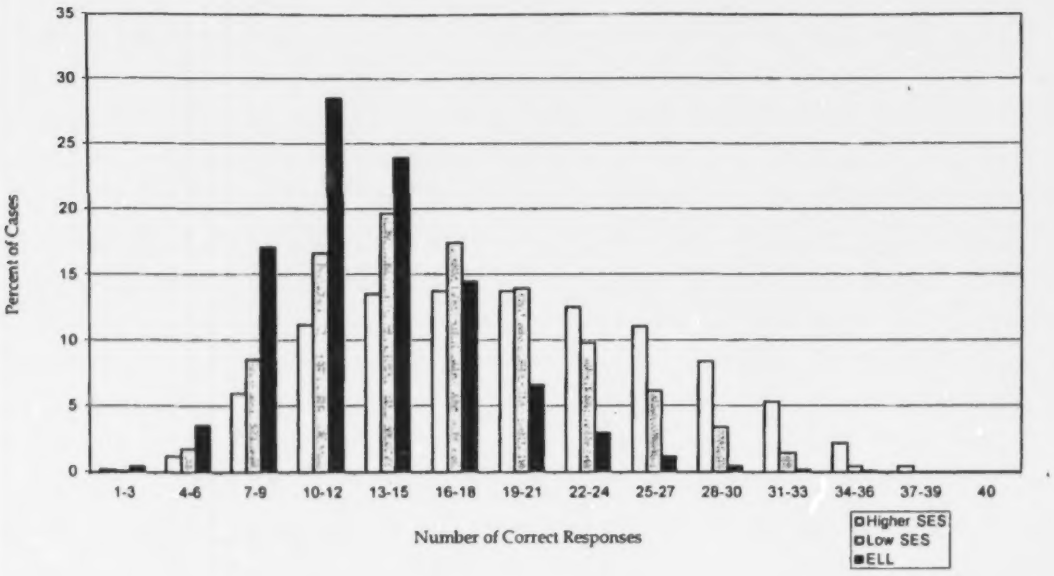

Figure 22. Site 2 Grade 7 social science distribution and reliability.

Table 52

Site 2 Grade 7 Social Science Distribution and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Higher SES	19.65	52.47	.837
Low SES	16.70	36.82	.767
LEP	13.12	20.90	.605

Figure 23 and Table 53 present results for math procedure scores for Grade 7. The distribution in this subsection more closely resembles the distribution of the social science subsection than the distributions we had seen in the reading and language subsections. The difference between the alphas for the higher SES (.892), low SES (.852), and LEP (.803) groups is smaller than what has just been described in the social science subsection.

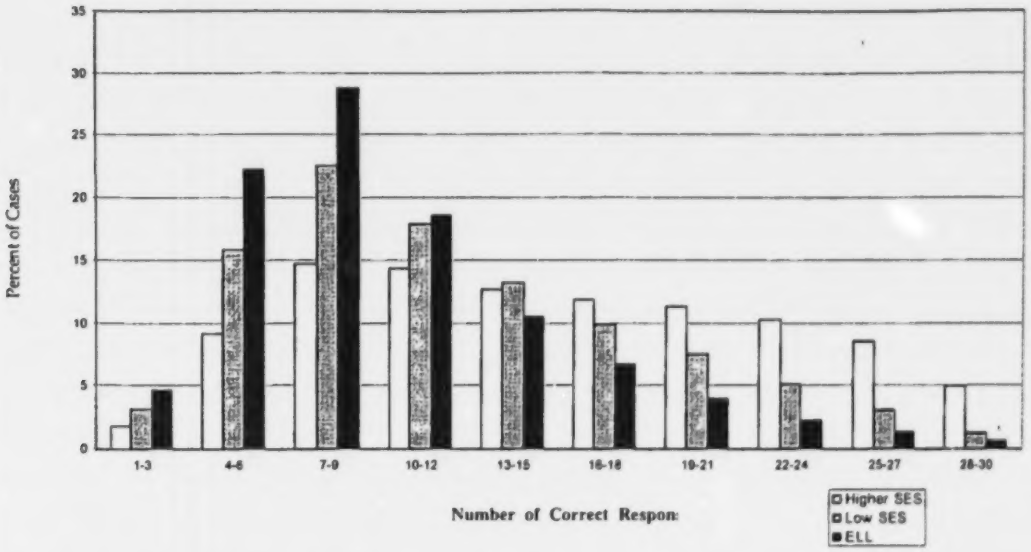

Figure 23. Site 2 Grade 7 math distribution and reliability.

Table 53

Site 2 Grade 7 Math Distribution and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Higher SES	15.38	51.38	.892
Low SES	12.07	38.03	.852
LEP	10.06	28.19	.803

The results of all these analyses, once again, suggest that even though LEP status may be partially confounded with SES and other background characteristics, it may not be explained by those characteristics alone.

Comparing performance of LEP and non-LEP students. The results of analyses comparing LEP and non-LEP students indicate that LEP students performed substantially lower than non-LEP students. This finding was consistent across grade levels, test levels, and across different sites. The results of item-level analyses were also consistent with the general statement that non-LEP students outperform LEP students. However, individual items may differentially separate LEP from non-LEP students. That is, some test items may show a larger performance difference between LEP and non-LEP students than other items.

To examine the level of differential performance of items when comparing LEP and non-LEP students, we computed the difference between the mean scores for each individual item across the LEP and non-LEP categories, as discussed in the Site

1 section of this chapter. (In the Site 1 section, we compared bilingual and non-bilingual groups). We computed "DBN" (here, this is the difference between LEP and non-LEP performance) for each individual item. A negative DBN indicates that LEP students had performed higher than their non-LEP peers for that particular item. Table 54 summarizes the results of item-level analyses comparing LEP and non-LEP students.

There was a large difference between test items in assessing the performance difference between LEP and non-LEP students. For example, the DBN index in math ranged from .03 to .26 for Grade 2, from .03 to .39 for Grade 7, and from .02 to .32 for Grade 9. For language and reading, the range of DBN was even wider than the range for math. For language the range of DBN was from .05 to .45 in Grade 2, from -.01 to .32 in Grade 7, and from .04 to .31 in Grade 9. For reading the range was from .03 to .24 in Grade 2, from .02 to .50 in Grade 7, and from .03 to .44 in Grade 9.

Table 54

Site 2 Item-Level Response Differences Between LEP and Non-LEP Students (DBN)

Subsection/Grade	# of items	Minimum	Maximum	Average DBN
Math				
Grade 2	72	.03	.26	.12
Grade 7	80	.03	.39	.19
Grade 9	48	.02	.32	.16
Language				
Grade 2	44	.05	.45	.19
Grade 7	48	-.01	.32	.24
Grade 9	48	.04	.31	.19
Reading				
Grade 2	118	.03	.24	.14
Grade 7	84	.02	.50	.25
Grade 9	84	.03	.44	.24

The large differences between the performance of LEP and non-LEP students suggest that some of the test items could be more linguistically complex than others, regardless of the item content difficulty. Of course other factors, such as lack of construct knowledge or opportunity to learn, could contribute to these differences as well.

Site 3

Site 3 provided item-level data on SAT 9 for all students, as well as data on LEP status and whether or not students received accommodations. We computed the internal consistency coefficient (coefficient alpha) for each of the content areas for the total group, as well as for the subgroups that were formed based on language background. Thus, we obtained coefficient alphas for the reading, science, and math tests for the total population and for LEP, SWD, LEP/SWD, and non-LEP/non-SWD subgroups separately.

Table 55 summarizes the results of the reliability analyses for students in the various LEP subgroups. The alpha coefficients are reported separately for Grades 10 and 11 and for each of the three content areas (reading, science, and math). The alpha coefficient in reading was .87 for LEP students in Grade 10. This coefficient was .88 for non-accommodated LEP and .78 for accommodated LEP. For non-LEP students, the coefficient was .90. For Grade 11, the alpha coefficient was .87 for LEP students, .88 for non-accommodated LEP students, .80 for accommodated LEP students, and .90 for non-LEP students.

Table 55

Site 3 Reliability Coefficients for SAT 9 Reading, Science, and Math Sub-Tests by LEP and Accommodation Status

	Reading (54 items)		Science (40 items)		Math (48 items)	
	n	r_{tt}	n	r_{tt}	n	r_{tt}
Grade 10						
All LEP	328	.87	284	.64	338	.87
LEP/Non-acc.	174	.88	160	.69	167	.86
LEP/Acc.	154	.78	124	.54	171	.87
Non-LEP	10,000	.90	9,335	.75	9,345	.84
Grade 11						
All LEP	289	.87	248	.68	277	.87
LEP/Non-acc.	154	.88	136	.71	142	.87
LEP/Acc.	135	.80	112	.63	135	.87
Non-LEP	7,814	.90	7,176	.81	7,299	.89

In science, the internal consistency coefficients were generally lower than those reported for reading. This may be due to multi-dimensionality in the science construct/test. For Grade 10, the alpha coefficient was .64 for all LEP students (.69 for non-accommodated and .54 for accommodated) and .75 for non-LEP students. The alpha coefficients were slightly higher for Grade 11. The internal consistency was .68 for all LEP students (.71 for non-accommodated and .63 for accommodated) and .81 for non-LEP students.

Internal consistency coefficients of the math test by subgroups were higher than those reported for science and were slightly lower than those reported for reading. For Grade 10, the alpha coefficient was .87 for all LEP students (.86 for non-accommodated and .87 for accommodated) and .84 for non-LEP students. For Grade 11, the alpha was .87 for all LEP students (.87 for both non-accommodated and accommodated) and .89 for non-LEP students.

As the data in Table 55 suggest, there is a trend toward lower reliability coefficients for LEP students, particularly accommodated. This trend was evident in the areas of reading and science, where language factors have greater impact. For example, the alpha coefficients were generally lowest in these areas for the accommodated LEP students. We indicated earlier that these students had lower

reading scores, and this was probably the main reason why they received accommodations. It must be indicated at this point that the internal consistency coefficients for different subgroups were based on different numbers of students. The number of non-LEP students (from 7,100 to 10,000) was much larger than the number of LEP students. The smaller number of subjects may cause a significant decrease in the size of the internal consistency coefficient due to the restriction of range problem (see, for example, Allen & Yen, 1979, pp. 194-196).

As in the previous sites, we adjusted the reliability coefficients by the number of items in the test. Table 56 presents the reliability coefficients that were reported in Table 55, but were adjusted by the number of items. The science and math tests were adjusted by the number of items (54) in the reading test, since the reading test had the largest number of items.

Table 56

Site 3 Adjusted Reliability Coefficients for SAT 9 Reading, Science, and Math Sub-Tests by LEP and Accommodation Status, Site 3

	Reading (54 items)		Science (40 items)		Math (48 items)	
	n	r_{xx}	*n*	r_{xx}	*n*	r_{xx}
Grade 10						
All LEP	328	.87	284	.71	338	.88
LEP/Non-acc.	174	.88	160	.75	167	.87
LEP/Acc.	154	.78	124	.61	171	.88
Non-LEP	10,000	.90	9,335	.80	9,345	.86
Grade 11						
All LEP	289	.87	248	.74	277	.88
LEP/Non-acc.	154	.88	136	.77	142	.88
LEP/Acc.	135	.80	112	.70	135	.88
Non-LEP	7,814	.90	7,176	.85	7,299	.90

Comparing the adjusted reliabilities in Table 56 with the unadjusted reliabilities in Table 55 showed a slight improvement in the reliabilities. The reliability gap between LEP and non-LEP students also decreased slightly, but the trend of lower reliability for LEP students remained.

Figure 24 and Table 57 present results for reading comprehension scores for Grade 10. The raw score distribution seen in Figure 24 indicates a large positive skew for the accommodated LEP students with the majority of these students correctly responding to between 12 and 19 questions. The distribution for LEP students with no accommodation was also positively skewed, although to a lesser degree than the accommodated LEP students. In comparison, the correct responses for non-LEP students approximate a normal distribution. The difference between the alphas for the non-LEP (.90), LEP with no accommodation (.88), and LEP with accommodation (.78) may be due in part to a restriction of range issue. The large degree of positive skew in the LEP with accommodation group results in a small variance (47.18) compared to the other two groups.

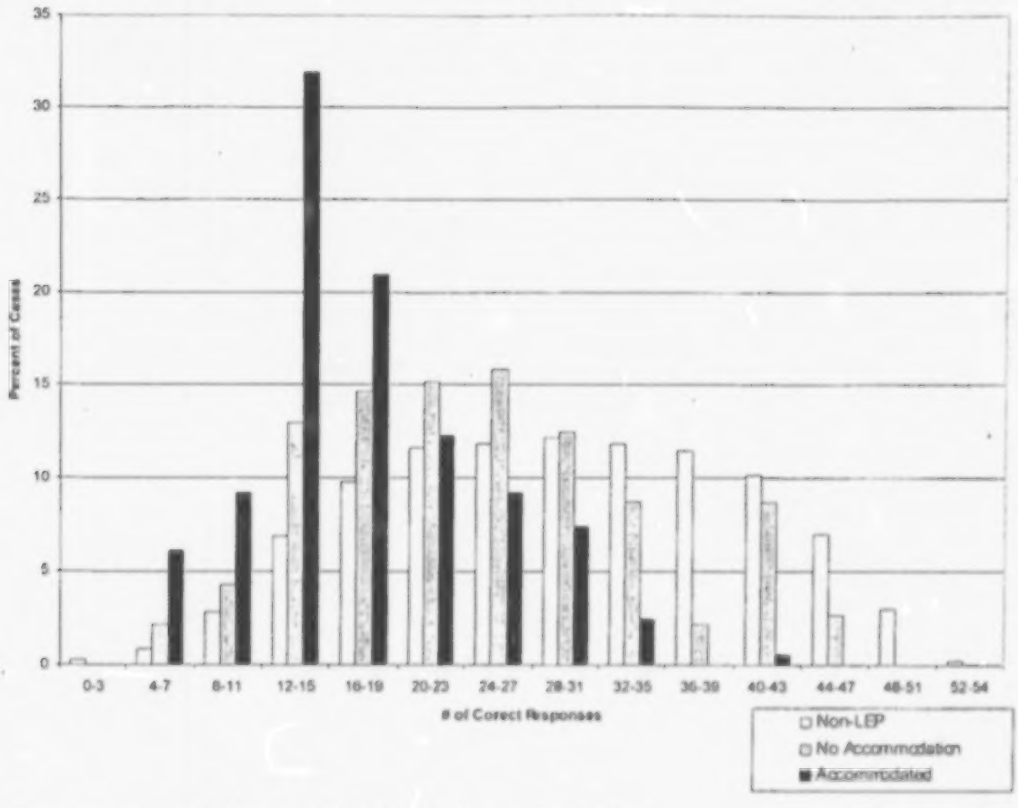

Figure 24. Site 3 Grade 10 Reading distribution and reliability.

Table 57

Site 3 Grade 10 Reading Distribution and Reliability

LEP/Accommodation status	Mean	Variance	Cronbach's alpha
Non-LEP	29.34	113.33	.90
No accommodation	24.49	93.20	.88
Accommodated	17.38	47.18	.78

Figure 25 and Table 58 present results for math scores for Grade 10. The raw score distribution patterns are similar for non-LEP, LEP students without accommodation, and LEP students with accommodation. Each group has a positively skewed distribution. The alpha coefficients, mean correct responses, and variances are also similar for the three groups of students.

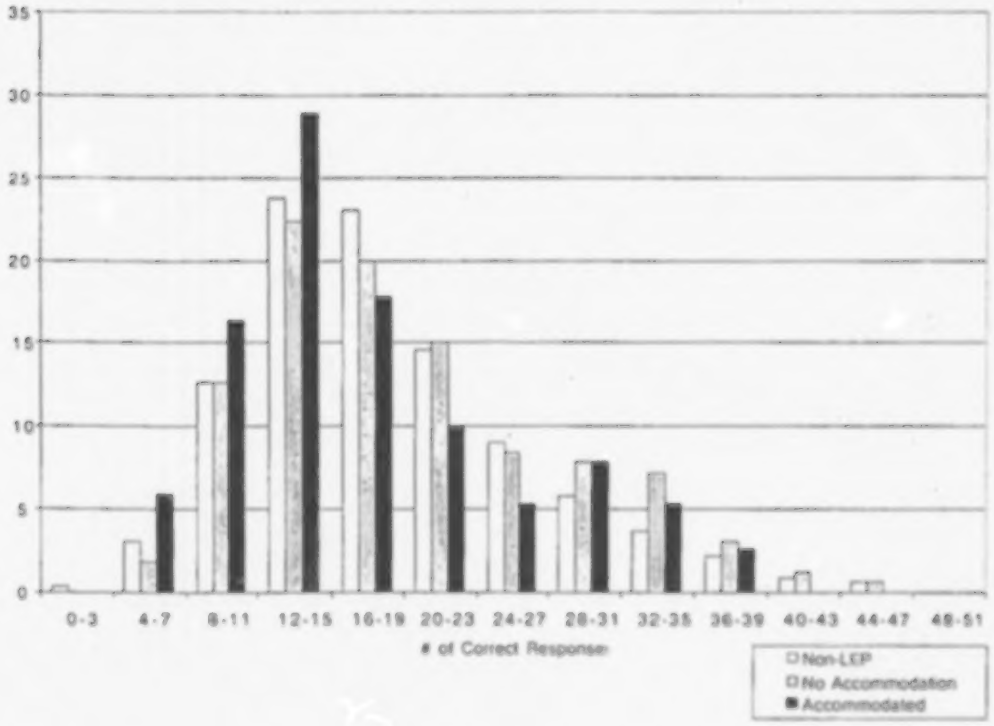

Figure 25. Site 3 Grade 10 math distribution and reliability.

Table 58

Site 3 Grade 10 Math Distribution and Reliability

LEP/Accommodation status	Mean	Variance	Cronbach's alpha
Non-LEP	18.38	60.34	.837
No accommodation	19.75	68.91	.863
Accommodated	18.67	74.13	.875

Item characteristics. As demonstrated earlier, LEP/SWD students generally perform lower than the non-LEP/non-SWD students. This trend can be observed systematically in the individual test items. That is, the proportions of correct response (in multiple-choice items) or mean performance scores (in performance items) were generally lower for LEP/SWD students. However, there was a large

difference between the individual test items in terms of differential treatment between LEP and non-LEP students. Some of the test items showed a much larger gap than others in performance between the LEP and non-LEP groups. To present a picture of this phenomenon, item difficulty indices (*p*-value—proportion of correct response in multiple-choice items) were compared across the LEP and non-LEP categories and an index, called differential treatment index (DTI), was computed. The DTI is simply the difference between *p*-values of the items across the LEP and non-LEP groups. We categorized DTI into three different categories: (a) small difference, a difference between the LEP and non-LEP groups of less than 9 percentage points, (b) moderate difference, a difference between 10 and 20 percentage points, and (c) large difference, a difference greater than 20 percentage points.

Table 59 presents the DTIs for all three content areas for Grades 10 and 11. Based on the data in Table 56, for all LEP students in Grade 10, 18% of the reading items had small DTI, 54% showed moderate DTI, and 28% had large DTI. For the non-accommodated students, the percentages were 54%, 44%, and 2%, respectively; and for the accommodated students, the respective percentages were 11%, 30%, and 59%. The results of DTI computation for the Grade 10 science test items for all LEP students showed that 88% of the items had small DTI; 10% had moderate DTI; and 2% had large DTI. The percentages were 95%, 5%, and 0%, respectively, for the non-accommodated group and 68%, 22%, and 10%, respectively, for the accommodated group. For the Grade 10 math items, the DTI for all LEP students was 100% in the small category and 0% in the moderate and large categories. For non-accommodated students, the respective percentages were 100%, 0%, and 0%, and for accommodated students, the percentages were 88%, 12%, and 0%, respectively.

Table 59

Site 3 Item Level Data: Raw Score *p*-Value Difference With Non-LEP Students as a Reference—Reading, Science, and Math SAT 9 Scores

	Percent of items with small, moderate & large *p*-value differences								
	Reading (54 Items)			Science (40 Items)			Math (48 Items)		
	Small	Mod.	Large	Small	Mod.	Large	Small	Mod.	Large
Grade 10									
All LEP	18%	54%	28%	88%	10%	2%	100%	0%	0%
Non-acc.	54%	44%	2%	95%	5%	0%	100%	0%	0%
Acc.	11%	30%	59%	68%	22%	10%	88%	12%	0%
Grade 11									
All LEP	11%	56%	33%	73%	23%	5%	98%	2%	0%
Non-acc.	37%	52%	11%	85%	10%	5%	100%	0%	0%
Acc.	4%	30%	67%	68%	20%	13%	90%	10%	0%

Note. All SWD students have been excluded from this table. A small difference was considered as less than 9 percentage points; a moderate difference as 10 to 20 percentage points; and a large difference as greater than 20 percentage points.

Table 60 presents item-level response differences between LEP and non-LEP students. Due to space limitations, we did not report response differences between each individual item. Instead, we reported the minimum, the maximum, and the average differences between responses to the items. The DBN (difference between LEP and non-LEP students) was highest for reading, lower for science, and lowest for math. The average DBN over the two grade levels in reading, science, and math was .24, .08, and 0.0, respectively. That is, a big reduction trend can be seen in the average DBN from reading to science and from science to math. In the area of math, no major performance differences were found between LEP and non-LEP students.

Table 60

Site 3 Item-Level Response Differences Between LEP and Non-LEP Accommodated Students (DBN)

Subsection/Grade	# of items	Minimum	Maximum	Average DBN
Reading				
Grade 10	54	-.06	.45	.23
Grade 11	54	.01	.54	.24
Science				
Grade 10	40	-.17	.35	.07
Grade 11	40	-.06	.45	.08
Math				
Grade 10	48	-.13	.14	.00
Grade 11	48	-.14	.20	-.01

Site 4

Reliability. Internal consistency coefficients were computed on item-level SAT 9 data in reading, math, and science from Site 4. Table 61 presents a summary of internal consistency analyses for Grades 3, 5, 7, and 9. Internal consistency coefficients are presented for LEP and non-LEP students. The non-LEP group was divided into higher and low SES. Reporting internal consistency coefficients by SES groups help us understand the impact of SES on test scores and to determine how much of the reliability difference between LEP and non-LEP may be explained by SES.

Table 61

Reliability Coefficients for SAT 9 Reading Comprehension, Math Problem Solving, and Math Procedures by LEP and SES Status

	Number of students	Reading comprehension (54 items)	Math problem solving (48 items)	Math procedures (30 items)
	n	r_{tt}	r_{tt}	r_{tt}
Grade 3				
All LEP	311	.869	.843	.867
Non-LEP/Low SES	2296	.916	.896	.883
Non-LEP/Higher SES	3708	.928	.902	.886
Grade 5				
All LEP	285	.805	.836	.844
Non-LEP/Low SES	2090	.904	.890	.875
Non-LEP/Higher SES	3411	.910	.898	.885
Grade 7				
All LEP	265	.851	.828	.852
Non-LEP/Low SES	1891	.915	.873	.860
Non-LEP/Higher SES	3096	.900	.893	.880
Grade 9				
All LEP	290	.870	.833	NA
Non-LEP/Low SES	1491	.936	.896	NA
Non-LEP/Higher SES	3229	.928	.910	NA

As data in Table 61 show, the SAT 9 test scores for LEP students were less reliable than for non-LEP students. The difference between reliability coefficients for the LEP and non-LEP groups was largest in reading, then in math problem solving, and smallest in math procedures. There was also a small increasing trend in the reliability difference for higher grades. Once again, these results are consistent with the results that were presented earlier based on the data from other sites.

To remove the influence of the number of items on the reliabilities, we adjusted the reliabilities to reflect a constant length of 54 items. Table 62 presents the adjusted reliability coefficients. The LEP and non-LEP reliability differences were smallest in math procedures. The reliability coefficients and LEP and non-LEP reliability gaps were similar in reading comprehension and math problem solving, where the language demand was higher than in math procedures.

Table 62

Adjusted Reliability Coefficients for SAT 9 Reading Comprehension, Math Problem Solving, and Math Procedures by LEP and SES Status (Based on 54 Items)

	Number of students	Reading comprehension	Math problem solving	Math procedures
	n	r_{tt}	r_{tt}	r_{tt}
Grade 3				
All LEP	311	.869	.858	.921
Non-LEP/Low SES	2296	.916	.906	.931
Non-LEP/Higher SES	3708	.928	.912	.933
Grade 5				
All LEP	285	.805	.852	.907
Non-LEP/Low SES	2090	.904	.901	.926
Non-LEP/Higher SES	3411	.910	.908	.933
Grade 7				
All LEP	265	.851	.844	.912
Non-LEP/Low SES	1891	.915	.885	.917
Non-LEP/Higher SES	3096	.900	.904	.930
Grade 9				
All LEP	290	.870	.849	NA
Non-LEP/Low SES	1491	.936	.906	NA
Non-LEP/Higher SES	3229	.928	.919	NA

Figure 26 shows Grade 7 raw score distributions for LEP and non-LEP students in reading and also presents descriptive statistics for the LEP and non-LEP groups. Table 63 presents overall means and variances as well as average reliability coefficients for Grade 7 in Site 4. For non-LEP students, separate distributions are presented for higher SES and low SES groups. The distributions of scores for the two non-LEP groups were skewed to the left (negative skew). For LEP students, the distribution was slightly skewed to the right (positive skew). However, the SES level of the non-LEP students appears to impact the distribution. The higher SES/non-LEP group had more of a negative skew than the low SES group. The distribution for the low SES/non-LEP group lay between the LEP and higher SES/non-LEP distributions. As indicated earlier, in reading, the low SES students scored lower than higher SES students, but not as low as LEP students. These results suggest that

language factors may have a greater impact on performance than SES factors. Figure 27 presents the distribution of scores for Grade 7 LEP and non-LEP students in math problem solving, and also presents the descriptive statistics for the three groups of students. Table 64 presents the means and variances as well as reliability coefficients for the math problem solving for Grade 7 in Site 4. Comparing Figure 27 with Figure 26 revealed similarities and differences between the data presented by the two figures. Similar to the data that were presented in Figure 26 for reading, in math problem solving, the distribution of scores for LEP students was positively skewed. However, for higher SES/non-LEP students, the distribution of scores was more symmetric. For low SES/non-LEP students, the math problem solving distribution was slightly positively skewed. Thus, the differences between LEP and non-LEP distributions were smaller in math problem solving.

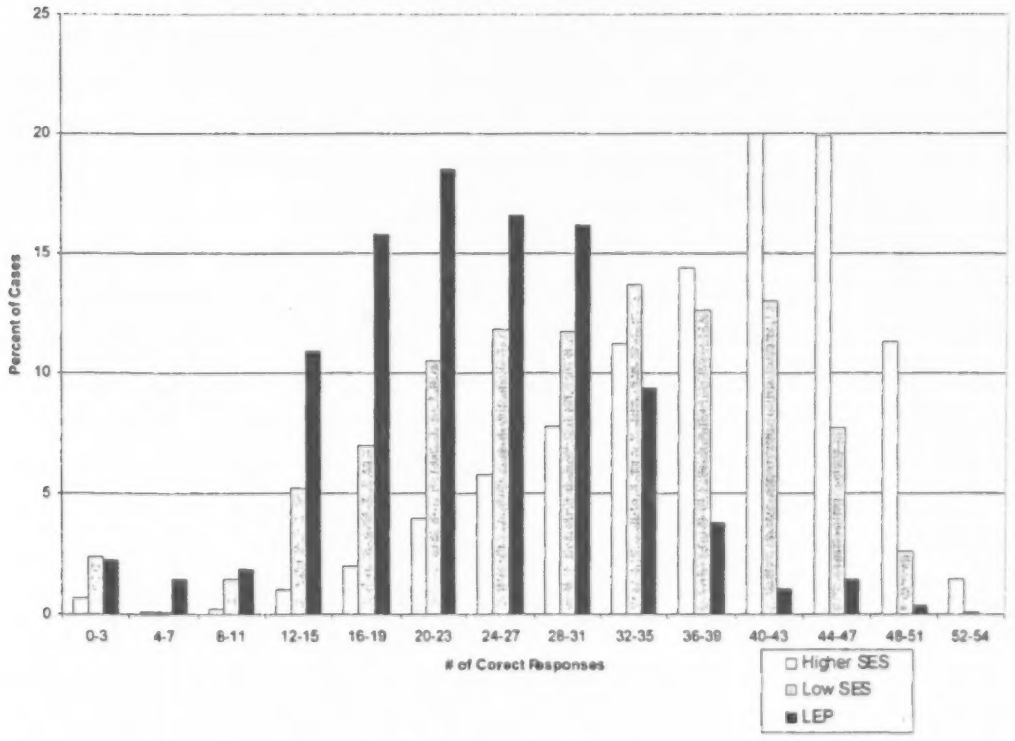

Figure 26. Site 4 Grade 7 reading distributions and reliability.

Table 63

Site 4 Grade 7 Reading Distributions and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Non-LEP/Higher SES	38.09	85.65	.900
Non-LEP/Low SES	30.37	117.68	.915
LEP	23.44	74.69	.851

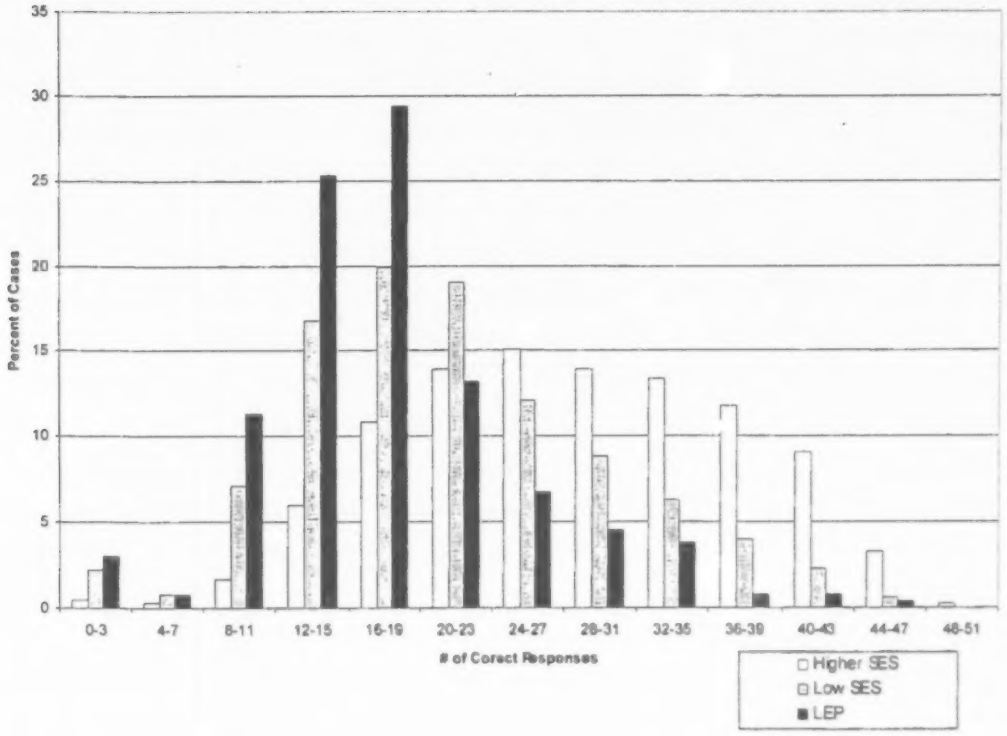

Figure 27. Site 4 Grade 7 math problem solving distributions and reliability.

Table 64

Site 4 Grade 7 Math Problem Solving Distributions and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Non-LEP/Higher SES	28.12	83.67	.893
Non-LEP/Low SES	21.11	74.81	.873
LEP	17.70	54.67	.828

The differences between the score distributions of the LEP and non-LEP groups were even smaller in math procedures. Figure 28 compares the three math procedures' raw score distributions for Grade 7. Table 65 presents the means and variances as well as reliability coefficients for math procedures for Grade 7 in Site 4. The LEP and non-LEP/low SES distributions were quite similar to each other, while different from the non-LEP/higher SES distribution.

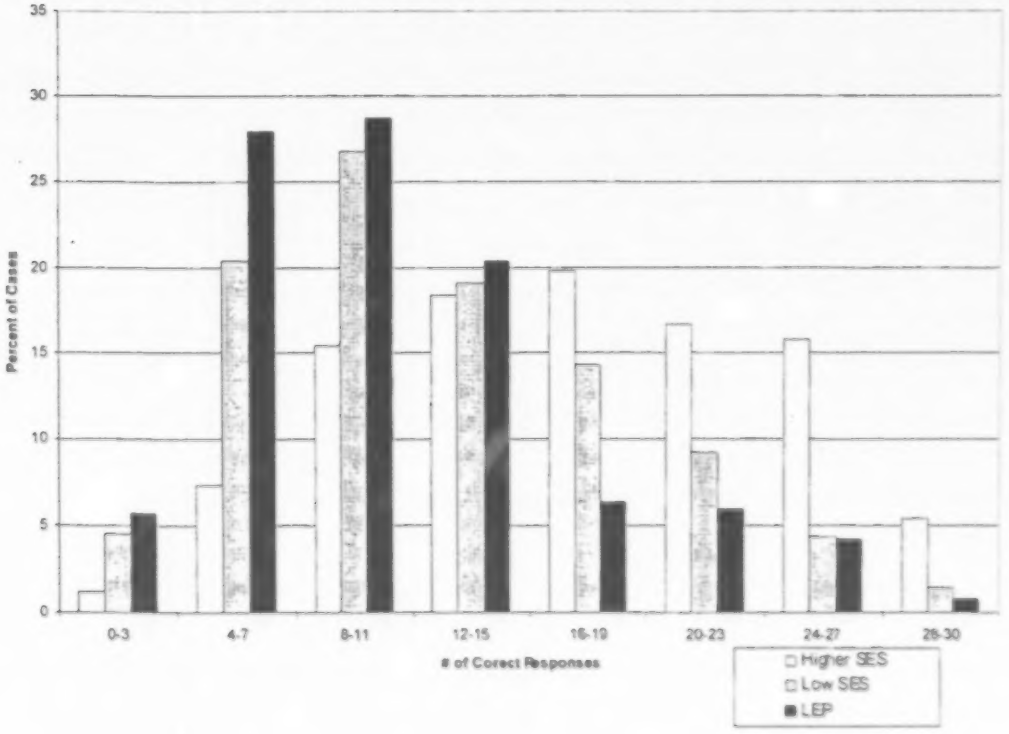

Figure 28. Site 4 Grade 7 math procedures distributions and reliability.

Table 65

Site 4 Grade 7 Math Procedures Distributions and Reliability

LEP/SES status	Mean	Variance	Cronbach's alpha
Non-LEP/Higher SES	17.03	45.29	.880
Non-LEP/Low SES	12.26	39.98	.860
LEP	10.78	36.34	.852

To compare performance of LEP and non-LEP students at the item-level, we computed the DBN index on each individual item. Table 66 summarizes the results of these analyses. We presented a summary of DBN by subject areas and by grade level. The performance difference between LEP and non-LEP students was smaller in math (problem solving and procedures) than in reading. This finding was consistent with our earlier findings that performance difference between LEP and non-LEP students is smaller in content areas (such as math and science) where language may not have much impact as in other areas (such as reading).

Table 66

Item-Level Response Differences Between LEP and Non-LEP Accommodated Students (DBN)

Subsection/Grade	# of items	Minimum	Maximum	Average DBN
Reading				
Grade 3	54	.10	.38	.25
Grade 5	54	.02	.46	.28
Grade 7	54	.00	.52	.27
Grade 9	54	.09	.49	.27
Math problem solving				
Grade 3	48	.00	.36	.20
Grade 5	48	.09	.43	.24
Grade 7	48	.05	.48	.22
Grade 9	48	-.02	.34	.17
Math procedures				
Grade 3	30	.07	.39	.21
Grade 5	30	.08	.42	.25
Grade 7	30	.07	.36	.21

Multivariate Analyses

Site 1

Regression analyses. To investigate the strength of the relationships among bilingual status and test scores, various regression models were explored. Bilingual status was used as a dependent variable in a regression model in which test scores (math concepts and estimation, math problem solving and data interpretation, math computation, and reading), gender, and ethnicity were used as independent variables. To present a clearer picture of the association of ethnicity (a categorical variable with five categories) and bilingual status, we used criterion-scaling multiple regression methodology (see Pedhazur, 1997, pp. 501-505). Rather than creating k-1 dummy variables for the ethnic categories (where k is the number of categories), we used the ethnic group averages in one single variable called "ethnicity." Thus, in the criterion-scaling regression model, each individual's value on the variable "ethnicity" is the mean score of the particular ethnic group of which the individual is a member. Because the math subsection NCE scores were highly correlated, to avoid the multi-collinearity problem, we used the math total NCE score instead of the math subsection scores.

A separate multiple regression analysis was conducted for each of the three grades. Table 67 summarizes the results of multiple regression analyses for students in these grades.

Table 67

Site 1 Grades 3, 6, and 8 Multiple Regression Results

Variable	B	SE B	ß	t	Sig t
Grade 3					
Math total	.0005	.0001	.025	4.479	<.0005
Reading	-.0039	.0001	-.173	-30.851	<.0005
Gender	.0144	.0030	.018	4.431	<.0005
Ethnicity	.9940	.0060	.623	153.350	<.0005
Constants	.1010	.0060			
	R = 0.647		R^2 = 0.418		
Grade 6					
Math total	-.0006	.0001	-.036	-5.120	<.0005
Reading	-.0047	.0001	-.237	-33.730	<.0005
Gender	.0006	.0030	.001	.175	.8610
Ethnicity	1.0130	.0110	.453	88.150	<.0005
Constants	.2160	.0070			
	R = 0.518		R^2 = 0.268		
Grade 8					
Math total	-.0008	.0001	-.046	-5.94	<.0005
Reading	-.0043	.0001	-.233	-29.99	<.0005
Gender	.0073	.0030	.013	2.26	.0240
Ethnicity	1.0140	.0160	.365	64.70	<.0005
Constants	.2200	.0070			
	R = 0.447		R^2 = 0.200		

As the data in Table 67 suggest, the results of multiple regression analyses were consistent across the three grades and indicate that test scores and ethnicity are powerful predictors of bilingual status. The multiple R for the Grade 3 regression model was .647 and R^2 for this model is 0.418, indicating that about 42% of the variance of bilingual status can be explained by math and reading test scores, ethnicity, and gender. In the Grade 3 model, all predictors had a significant contribution to the prediction. Among the predictors, ethnicity (the criterion-scaled variable) had the highest level of contribution to the prediction. The *t*-ratios for testing the significance of prediction were significant above and beyond the .01 nominal level for all four predictor variables. Once again, the beta coefficients suggest that ethnicity was the strongest predictor of student bilingual status. For the

math and reading variables, reading (beta = -0.173) had a higher level of contribution to the prediction of bilingual status than math (beta = 0.025).

As indicated earlier, the results of the multiple regression analyses were consistent across the three grades. All three models suggest that ethnicity was the strongest predictor of bilingual status, with the highest magnitude of the beta coefficient. The next strongest predictor was reading, followed by math. One difference among the results for the different grades was that the strength of association decreases in the higher grades. R^2 for the Grade 3 model was .418 (42% of the variance of bilingual status is explained). For Grade 6, R^2 was .268 (27% of the variance of bilingual status is explained), and for Grade 8, R^2 was .200 (20% of the variance of bilingual status is explained). Another difference was that in Grade 6, gender was not a significant predictor of bilingual status, whereas gender was significant in Grades 3 and 8. However, the gender differences were so small as to be not meaningful. Finally, the directionality of math as a predictor of bilingual status was reversed in Grade 3, where higher math totals are associated with bilingual membership. However, the math effect in all three grades was quite small in comparison to the effects of reading and ethnicity.

Multivariate analysis of variance. To ascertain the significance of the mean differences in the ITBS NCEs for the bilingual and non-bilingual populations, we employed a single-factor multivariate analysis of variance (MANOVA) model. In this model, bilingual status was the explanatory variable and the four ITBS subscale NCEs for reading, math problem solving and data interpretation, math concepts and estimation, and math computation were the outcome variables. We examined the data for Grade 8. The overall model was significant, with Wilks' lambda = .928, $F(1, 25232) = 487.76$, $p<.0001$. There was strong evidence that the two bilingual status populations differ in their overall ITBS test profiles. Table 68 presents the univariate results for the four separate ITBS subtests.

Table 68

Site 1 Grade 8 Univariate Results

Subtest	Error df	F	*p*-value	Eta-Squared
Reading	25235	1805.44	< .0001	.067
Math problem solving	25235	1121.89	< .0001	.043
Math concepts	25235	742.75	< .0001	.029
Math computation	25235	260.96	< .0001	.010

The results shown in Table 68 indicate that the bilingual and non-bilingual population means differ on *each* of the four subtests. The four non-bilingual population subtest means are higher than those in the bilingual population.

Table 68 also displays the strength of association measure *eta-squared* for each of the subtests. The eta-squareds rank the impact of bilingual status on the subtest scores. It is notable that this ranking coincides with the presumed level of English language demand in these subtests. The largest impact of bilingual status is in reading, while the smallest impact is in math computation where there is little English language demand involved.

Site 2

Canonical correlation analysis. Literature suggests that background variables impact performance in school (see for example, Abedi, Lord, & Plummer, 1997; Abedi, Lord, & Hofstetter, 1998; Abedi, Hofstetter, Lord, & Baker, 1998; Cocking & Chipman, 1988; Garcia, 1991; LaCelle-Peterson & Rivera, 1994). Among these background variables, SES was one of the strongest predictors of school achievement. To examine the importance of language factors in predicting performance above and beyond other background variables, a canonical correlation model was created. In this model, SAT 9 subsection scores were related to SES, parent education, and LEP status. The purpose of this analysis was to determine how much of the variance of achievement scores could be explained by the LEP status above and beyond the parent education and SES variable.

We created three canonical correlation models, one each for Grades 2, 7, and 9. The independent (Set 2) variables in all three models were LEP status, parent education, and SES status. For Grades 2 and 7, the canonical model included SAT 9 subsection NCE scores in reading, math, language, and spelling as the dependent

(Set 1) variables. For Grade 9, the dependent variables were the reading, math, language, science, and social science NCE scores.

Table 69 presents a summary of the results of the canonical analysis for Grade 2. The canonical model yielded three functions, of which only the first was statistically significant (Wilks' Lambda = .70, $p<0.001$) and explained over 29% of the shared variance. The canonical correlation for this model was .542. All of the correlations of the Set 1 variables with the canonical variate were high, ranging from .766 (math) to .976 (reading). However, some of the correlations between the Set 2 variables and the canonical variate were not as high as in Set 1. Among the Set 2 variables, parent education had the highest correlation with the canonical variate (.912), while LEP status had a moderate correlation with the canonical variate (-.697), and SES had a relatively small correlation with the canonical variate (-.475).[1]

The academic performance (Set 1) canonical variate consisted mostly of the reading and language scores, as shown by the standardized canonical coefficients of .684 and .405, respectively. Math and spelling made negligible contributions to the Set 1 canonical variate. The background (Set 2) canonical variate was mostly the parent education variable (standardized coefficient = .714), with smaller contributions from LEP status (-.383) and SES (-.173).

The results of the canonical analysis described above suggest that there is a high degree of inter-correlation in student performance among the different subject areas; that is, students who perform high in one of the four subject areas are expected to perform high in other areas. This result suggests that language may be an underlying factor in achievement. It may also point to an underlying scholastic aptitude factor. The results also suggest that academic achievement is highly dependent on family and language factors, such as SES, parent education, and LEP status.

[1] The negative sign of the correlation of a variable with the canonical variate is due to the reverse coding of the variable.

Table 69

Site 2 Grade 2 Correlations Between Performance and Background Variables and First Canonical Variate, Standardized Canonical Coefficients, Percent of Variance Explained, and Canonical Correlation

	First canonical variate	
Variable	Correlation	Coefficient
Set 1 (dependent) variables		
Reading	.976	.684
Math	.766	-.072
Language	.926	.405
Spelling	.809	.014
Set 2 (independent) variables		
Parent education (ordered categories)	.912	.714
LEP status (categorical)	-.697	-.383
SES (ordered categories)	-.475	-.173
Canonical correlation	.542	
Percent of shared variance explained by first canonical pair	29.4	

Table 70 summarizes the results of the canonical analysis for Grade 7. As in the Grade 2 model, the Grade 7 model used the four subsection scores (reading, math, language, and spelling) as the Set 1 (dependent) variables and LEP status, SES, and parent education as the Set 2 (independent) variables.

The Grade 7 canonical model also yielded three functions, of which only the first was statistically significant (Wilks' Lambda = .67, $p<0.001$) and explained over 31% of the shared variance. The canonical correlation was .558. All of the correlations of the Set 1 variables with the canonical variate were high, ranging from .800 (math) to .988 (reading). As in Grade 2, the correlations between the Set 2 variables and the canonical variate were not as high as in Set 1. Among the Set 2 variables, parent education and LEP status strongly correlated with the canonical variate (.808 and -.805, respectively), while SES had a smaller correlation with the canonical variate (-.518).

For Grade 7, the reading score (standardized coefficient = .767) dominated in the canonical variate of the academic performance variables, while spelling made a minor contribution. Surprisingly, the language score made virtually no contribution (standardized coefficient = .028) to this canonical variate. The math contribution was also essentially nil. The canonical variate of the background variables consisted

mostly of LEP status and parent education (in roughly equal portions), with a much smaller contribution from the SES index.

Table 70

Site 2 Grade 7 Correlations Between Performance and Background Variables and First Canonical Variate, Standardized Canonical Coefficients, Percent of Variance Explained and Canonical Correlation

	First canonical variate	
Variable	Correlation	Coefficient
Set 1 (dependent) variables		
Reading	.988	.767
Math	.800	.035
Language	.870	.028
Spelling	.854	.222
Set 2 (independent) variables		
Parent education (ordered categories)	.808	.540
LEP status (categorical)	-.805	-.558
SES (ordered categories)	-.518	-.221
Canonical correlation	.558	
Percent of shared variance explained by first canonical pair	31.2	

Table 71 summarizes the results of the canonical analysis for Grade 9. The model used five subsection scores (reading, math, language, science, and social science) as the Set 1 (dependent) variables, and LEP status, SES, and parent education as the Set 2 (independent) variables.

The Grade 9 canonical model again yielded three functions, of which only the first was statistically significant (Wilks' Lambda = .69, $p<0.001$) and explained more than 29% of the shared variance. The canonical correlation was .544. All of the correlations of the Set 1 variables with the canonical variate were high, ranging from .776 (social science) to .990 (reading). As in Grades 2 and 7, the correlations between the Set 2 variables and the canonical variate were not as high as for Set 1. Among the Set 2 variables, parent education and LEP status strongly correlated with the canonical variate (.861 and -.753, respectively), while SES had a smaller correlation with the canonical variate (-.397).

In the Grade 9 model, the academic performance canonical variate was almost exclusively the reading score (standardized coefficient = .758). The other academic variables made very small contributions (each standardized coefficient is at most .120). Parent education and LEP status again dominate in the background canonical variate.

Table 71

Site 2 Grade 9 Correlations Between Performance and Background Variables and First Canonical Variate, Standardized Canonical Coefficients, Percent of Variance Explained and Canonical Correlation

	First canonical variate	
Variable	Correlation	Coefficient
Set 1 (dependent) variables		
Reading	.990	.758
Math	.797	.074
Language	.853	.089
Science	.817	.120
Social science	.776	.022
Set 2 (independent) variables		
Parent education (ordered categories)	.861	.657
LEP status (categorical)	-.753	-.506
SES (ordered categories)	-.397	-.135
Canonical correlation	.544	
Percent of shared variance explained by first canonical pair	29.6	

In all three grades, the academic variable that correlated most highly with the canonical variate was reading (.976 to .990). Among the background variables, parent education and LEP status correlated most strongly with the canonical variate (magnitudes greater than .69). Taken together, the results of the multivariate canonical correlation analyses confirm our earlier findings that suggest that language background has significant impact on academic performance.

Regression analyses. To further examine the contribution of LEP status to predicting performance, a series of regression models was examined for the Grade 9 data. The dependent variables were the NCE scores on the reading, language, math, science, and social science subtests. For each subtest, three models were examined.

Model 1 was a simple regression model with the SES index as the predictor variable. Model 2 used the SES index and parent education as the predictor variables. Model 3 used three predictor variables: the SES index, parent education, and LEP status. Model 3 captures the contribution of LEP status over and above the contributions of SES and parent education level.

Table 72 presents a summary of the results of the regression analyses for Grade 9. Because of the large sample sizes, all models were significant with $p<.0005$ and all predictors were also significant with $p<.0005$. All of the Model 1 R^2s were small, ranging from .027 in social sciences to .046 in reading. In all content areas, R^2 increased substantially (and significantly) in Model 2 when parent education entered the prediction. The increase in R^2 was largest in reading (.173) and smallest in social sciences (.127). The increases in R^2 when LEP status entered the predictions (from Model 2 to Model 3) were small to modest in absolute size, but statistically significant, ranging from .022 in math to .071 in reading. With SES and parent education already in the reading model, the addition of LEP status increased the percent of reading variance explained from 21.9 to 29.0, an absolute increase of 7.1% and a relative increase of 34.2 %. The absolute (relative) increases in R^2 for the other subtests were: 4.4% (25.4%) in language, 2.2% (12.6%) in math, 3.4% (20.2%) in science, and 2.9% (18.8%) in social science. The standardized regression coefficients (the betas) suggest that in all five content areas, parent education is the most powerful of the three predictors, followed by LEP status. The negative betas for the LEP status and SES variables indicate that higher content NCEs are associated with the non-LEP and higher SES categories. As expected, higher NCEs are associated with higher levels of parent education.

Further analyses. To better understand the complex effects of parent education, SES, and LEP status on SAT 9 achievement, we used three different but related approaches:

1. 3-way full factorial Analysis of Variance (ANOVA) models;
2. Multiple regression models;
3. Change in R^2 with nested multiple regression models.

Table 72

Grade 9 Multiple Regression Results for All Subtests Except Spelling

Dep Var	Model 1 R^2	Model 2 R^2	Model 3 R^2	betas	
Reading	.046	.219	.290	SES	-.074
NCE		Δ = .173	Δ = .071	Parent Ed	.342
				LEP	-.284
Language	.031	.173	.217	SES	-.052
NCE		Δ = .142	Δ = .044	Parent Ed	.320
	.029	.174	.196	LEP	-.225
Math		Δ = .145	Δ = .022	SES	-.052
NCE				Parent Ed	.344
				LEP	-.159
Science	.032	.168	.202	SES	-.062
-.197		Δ = .136	Δ = .034	Parent Ed	.319
				LEP	-.197
Social sciences	.027	.154	.183	SES	-.053
-.197		Δ = .127	Δ = .029	Parent Ed	.311
				LEP	-.181

Note. Model 1 predictor: SES. Model 2 predictors: SES, parent education. Model 3 predictors: SES, parent education, and LEP status. Δ = change in R^2.

In the first approach, we used a full factorial three-way ANOVA model with reading and math NCEs as the outcome variables and parent education, SES, and LEP status as the explanatory variables. The reading and math cell means from the ANOVA are displayed in Table 73 and Table 74, respectively. All interactions and main effects were significant at $p<.0001$ (as expected, because of the large sample sizes). The significant 3-way interactions indicate that the effect of any one variable on the SAT 9 NCEs depends on the combination of the levels of the other two variables and that the joint effect of any two of the variables depends on the level of the third variable. For example, the effect of parent education on the SAT 9 reading NCE depends on the combination of SES and LEP status, and the joint effect of parent education and LEP status on the SAT 9 reading NCE depends on the level of SES. These effects are described in more detail in the following paragraphs.

Table 73

Site 2 SAT 9 Reading NCE Means

	Low SES						Higher SES					
	LEP			Non-LEP			LEP			Non-LEP		
Parent Ed	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*
< HS Grad	21.74	11.14	8592	34.73	14.55	9909	22.43	11.69	15114	34.05	15.19	21229
HS Grad	22.99	12.02	3205	34.81	15.82	8122	23.59	12.48	6463	38.83	16.85	35524
Some college	26.06	12.32	1134	40.55	16.00	5740	27.99	13.42	2591	46.56	16.75	41583
College Grad	25.12	12.70	1121	40.42	17.09	4677	28.89	14.57	3308	50.37	17.63	54513
Post Grad	23.72	12.39	358	44.30	19.39	1032	31.16	12.40	958	59.33	18.20	22989
TOTAL	22.67	11.67	14410	37.13	16.08	29480	24.25	12.90	28434	46.34	18.65	175838

Table 74

SAT 9 Math NCE Means

	Low SES						Higher SES					
	LEP			Non-LEP			LEP			Non-LEP		
Parent Ed	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*	Mean	*SD*	*N*
< HS Grad	35.61	12.49	8892	43.97	15.58	10110	35.23	12.86	15751	42.52	15.98	21506
HS Grad	38.12	14.83	3283	43.40	16.50	8264	37.04	14.47	6698	46.34	17.48	35949
Some college	41.11	15.33	1156	48.00	17.06	5789	41.33	15.74	2632	53.28	17.98	41854
College Grad	42.93	16.95	1131	48.56	18.17	4698	47.17	19.71	3391	57.95	19.34	54750
Post Grad	41.30	16.31	362	53.08	19.92	1040	49.59	21.77	988	67.18	19.89	23028
TOTAL	37.29	13.96	14824	45.63	16.91	29901	38.07	15.46	29460	53.82	19.80	177087

First consider reading NCE for low SES students (the left panel of Table 73). For the LEP subgroup, there was a rather weak relationship between the reading means and the level of parent education, with the "some college" and "college graduate" groups having higher means (26.06 and 25.12) than the "less than high school graduate" and "high school graduate" groups (21.74 and 22.99). Surprisingly, the "post graduate" group mean (22.67) ranked lower than expected--between the high school and college groups. A possible explanation is that some LEP students reported the wrong parent education category. Such students may have mistakenly thought that "post graduate degree" meant "graduated from elementary school" or "graduated from high school"—they may have focused on the word "graduate". It is thus possible that the "post graduate" mean was underestimated.

Continuing with low SES students, within the non-LEP subgroup the relationship between the reading NCE means and parent education level was stronger than in the LEP subgroup. The "less than high school graduate" and "high school graduate" means (34.73 and 34.81) were similar and lowest. The "some college" and "college graduate" means (40.55 and 40.42) were similar and considerably higher than the two high school group means. The "post graduate" mean (44.30) was the highest (as expected). Figure 29 shows these patterns graphically.

Figure 29 also shows how the gap between the LEP and non-LEP subgroups widened somewhat as parent education level increased: from 13 NCE points in the "less than high school graduate" group, to 15 points in the "college graduate" group, to more than 20 points in the "post graduate" group. However, the gap may have been overestimated in the "post graduate" group, because the LEP subgroup mean may have been underestimated, as mentioned earlier. Within the low SES group, the overall gap between LEP and non-LEP students was about 14.5 NCE points (a weighted average across all parent education levels).

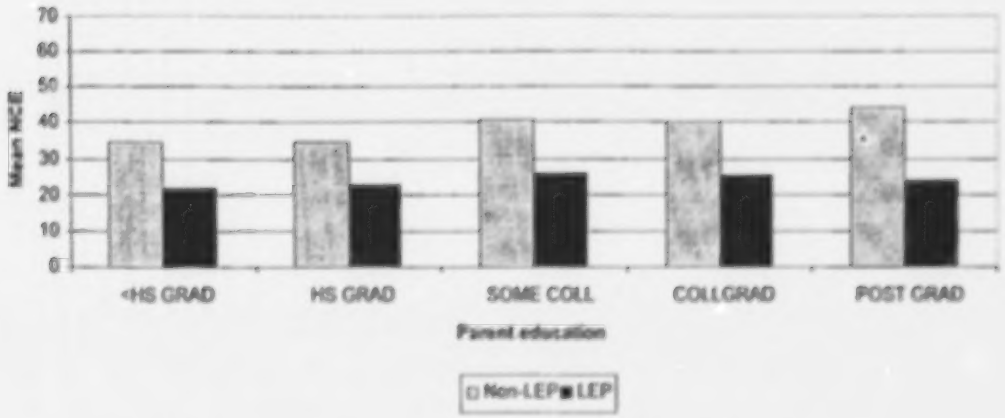

Figure 29. Site 2 Grade 9 reading NCE low SES by parent education and LEP status.

Turning now to the higher SES group (the right panel of Table 73), for LEP students the reading NCE means increased with increasing parent education level, with the largest increase from "high school graduate" (23.59) to "some college" (27.99) and a small increase from "college graduate" (28.89) to "post graduate" (31.16). The non-LEP student group again showed a stronger positive relationship between reading NCE mean and level of parent education, with a large increase at each higher level of parent education, and particularly large increases from "high school graduate" (38.83) to "some college" (46.56) and from "college graduate" (50.37) to "post graduate" (59.33).

The LEP and non-LEP gap increased dramatically from 11.6 at the "less than high school graduate" level to more than 21 at the "college graduate" level and more than 28 at the "post graduate" level. Figure 30 shows these patterns and also shows how much more dramatic the parent education effect was in the higher SES group, compared to the low SES group. Within the higher SES group, the overall LEP/non-LEP gap (averaged across parent education levels) was about 22 NCE points; this is considerably larger than the corresponding gap in the low SES group.

Among the three subgroups non-LEP/low SES, LEP/low SES, and LEP/higher SES, there was little NCE reading mean advantage (about 1 NCE point) to the "high school graduate" level versus the "less than high school graduate" level of parent education. In these subgroups there was also little

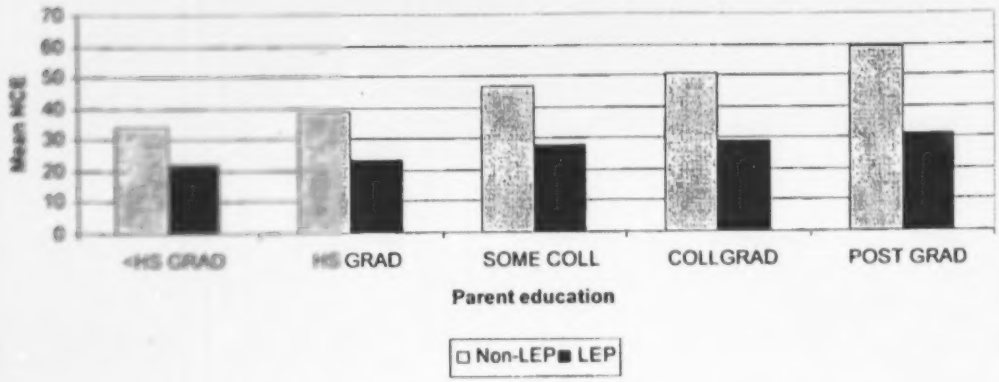

Figure 30. Site 2 Grade 9 reading NCE higher SES by parent education and LEP status.

difference between the "some college" and "college graduate" reading means. However, there was a gap (ranging from 3 to almost 6 points) between the "high school graduate" and "some college" levels; which was largest reading gap among these three subgroups. In contrast, for the LEP/higher SES subgroup, there was an almost 5-point advantage to being at the "high school graduate" level versus the "less than high school" level of parent education. There was also an increase of at least 4.75 points with each additional increase in level of parent education for this subgroup. Additionally, the largest gap in this subgroup was between the "college graduate" and "post graduate" levels, a gap of about 9 points.

In math, the trends and patterns were similar to those just described in reading, but generally were not as pronounced. For each comparable group, the math NCE mean was higher than the reading mean. One difference between math and reading occurred in the LEP/higher SES subgroup. In math, there was an approximate 6-point advantage to the "college graduate" level over the "some college" level of parent education; whereas in reading, the corresponding advantage was less than 1 point. The LEP and non-LEP math gaps generally were smaller than in reading. Within the low SES group, the LEP and non-LEP math gap was a little more than 8 points, while the reading gap was about 14.5 points. Within the higher SES group, the LEP and non-LEP math gap was about 15.7 points, compared with 22 points in reading. Figure 31 and Figure 32 show the trends in math for the low and higher SES groups, respectively.

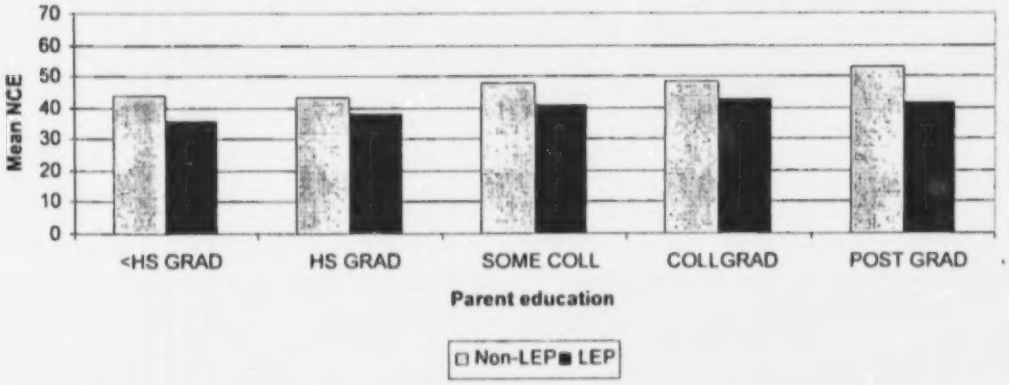

Figure 31. Site 2 Grade 9 math NCE low SES by parent education and LEP status.

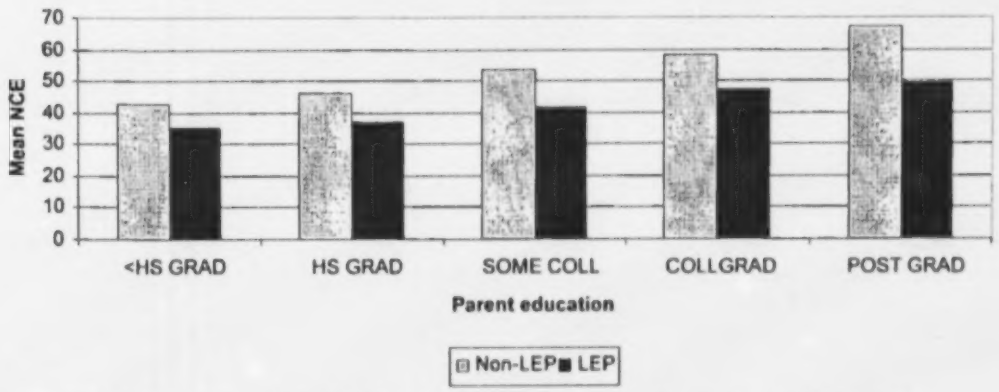

Figure 32. Site 2 Grade 9 math NCE higher SES by parent education and LEP status.

Table 75 shows the marginal (main effect) means for the various levels of the three explanatory variables. These marginal means are computed by aggregating across the levels of the other two variables. The LEP and non-LEP reading gap was approximately 21.5 NCE points on the average, while in math the gap was about 15 points. However, as described above, the LEP effect depends on the combination of SES and parent education levels. The overall SES

reading and math gaps were approximately 11 and 9 NCE points, respectively. However, the SES effect depends on the combination of LEP status and parent education levels. Similarly the parent education effect depends on the combination of SES and LEP status levels. The strongest parent education effect in both reading and math occurs in the non-LEP/higher SES group. The weakest parent education effect in both reading and math occurs in the LEP/low SES group. For both reading and math, within both levels of SES, the parent education effect was stronger in the non-LEP subgroup; and the parent education effect was much stronger for non-LEP students than for LEP students.

Table 75

Site 2 Grade 9 Marginal (Main Effect) Reading and Math NCE Means

	Reading			Math		
	Mean	*SD*	*N*	Mean	*SD*	*N*
LEP status						
LEP	23.72	12.53	42,844	37.81	14.98	44,284
Non-LEP	45.02	18.59	205,318	52.63	19.62	206,988
SES						
Low SES	32.38	16.26	43,890	42.87	16.47	44,725
Higher SES	43.26	19.52	204,272	51.57	20.01	206,547
Parent education						
Not high school Grad	29.04	14.85	54,844	39.64	15.06	56,259
High school Grad	35.42	17.00	53,314	44.24	17.18	54,194
Some college	44.49	17.22	51,048	51.80	18.04	51,431
College Grad	48.08	18.41	63,619	56.44	19.59	63,970
Post Grad	57.15	19.54	25,337	65.55	20.59	25,418
Grand total	41.34	19.44	248,162	50.02	19.71	251,272

For the Grade 9 reading data, Table 76 presents estimates of two measures of strength of association between the independent and dependent variables: eta-squared and omega-squared. (These measures are derived from sums of squares and degrees of freedom from the ANOVA summary table). Both measures indicate the same ranking in strength of association, with LEP status ranking highest, followed by parent education, then SES, and finally the interactions. Note that LEP status was estimated to be roughly three times as strong as parent education, which is roughly four times as strong as SES. However, these measures were based on using parent education as a nominal variable. Parent education was actually an ordinal variable, so the strength of association of parent education with the SAT 9 NCEs was underestimated by the ANOVA models.

Table 76

Site 2 Grade 9 Strength of Association and Standardized Regression Coefficients for Reading

Effect	Eta-squared	Omega-squared	Beta
LEP status	.049	.0356	-.142
Parent education	.017	.0121	.411
SES	.004	.0029	.088
Parent Ed by LEP	.003	.0021	-.166
Parent Ed by SES	.003	.0021	-.188
LEP by SES	.001	.0005	-.045
Parent Ed by LEP by SES	.001	.0016	.065

Eta-squared and omega-squared for the math model are presented in Table 77. Both measures indicated the same ranking in strength of association with math NCE: parent education was strongest, followed by LEP status. The other explanatory variables, including SES, were much less strongly associated with math NCE. The math ranking was different from the reading ranking. In reading, the ANOVA model ranked LEP status as the most strongly associated explanatory variable, while in math the ANOVA model ranked parent education as strongest.

Table 77

Site 2 Grade 9 Strength of Association and Standardized Regression Coefficients for Math

Effect	Eta-squared	Omega-squared	Beta
LEP status	.013	.0107	-.078
Parent education	.019	.0156	.400
SES	.003	.0021	.119
Parent Ed by LEP	.001	.0005	-.097
Parent Ed by SES	.003	.0025	-.193
LEP by SES	.001	.0004	-.043
Parent Ed by LEP by SES	.001	.0005	.061

Another approach to assessing the impact of the three explanatory variables is to create a multiple regression (MR) model utilizing the three explanatory variables and their interactions as predictors of the SAT 9 NCE scores. In such a multiple regression model, parent education is treated as an interval variable rather than as an ordinal variable. Thus the multiple regression model will overestimate the strength of parent education. Within such an MR model, the absolute values of the standardized regression coefficients rank the predictors in order of relative importance in the model.

The MR model for predicting reading NCE was significant at $p<.0001$ and with $R^2 = .303$. All variables and interaction were also significant at $p<.0001$. We see from Table 76 that among these predictors, parent education was the most important predictor for reading, with the largest standardized regression coefficient (beta = .411). After parent education, the predictors LEP status, the interaction of parent education and LEP status, and the interaction of parent education and SES were roughly similar in strength (with absolute betas of .142 to .188), but lower than parent education. SES and the other interactions were the least powerful predictors. However, the relative importance of parent education (and of the interactions involving parent education) was exaggerated in this MR model.

The math NCE regression model was significant at $p<.0001$ and with $R^2 = .206$. As with reading, all variables and interaction were also significant at $p<.0001$. We see from Table 77 that among these predictors, parent education was also the most important predictor for math, with the largest standardized

regression coefficient (beta = .400). After parent education, the interaction of parent education and SES was the next most important predictor of math NCE (beta = -.193). SES (beta = .119) and the interaction of parent education with LEP status (beta = -.097) contributed slightly more to the model than did LEP status (beta = -.078). In the presence of the interactions, LEP status contributed less to the math model than did parent education and SES. As discussed in the previous paragraph, the relative importance of parent education (and of the interactions involving parent education) was exaggerated in this MR model.

A third approach to assessing the effects of the three explanatory variables (and their interactions) on the SAT 9 NCEs is to create a sequence of nested regression models and assess the change in R^2 from model to model. A sequence of five regression models was created. In the first three models, the predictors SES, parent education, and LEP status were entered one-by-one. In Model 4 the three 2-way interactions were entered. Finally the 3-way interaction was entered in Model 5. Table 78 shows the five models and their R^2s.

Table 78

Site 2 Grade 9 Nested Regression Models with Predictors and R-squared

Model	Predictors	R^2 Reading	R^2 Math
1	SES	.046	.029
2	SES, parent Ed	.219	.174
3	SES, parent Ed, LEP	.290	.196
4	SES, parent Ed, LEP, 2-way interactions	.303	.206
5	SES, parent Ed, LEP, 2- & 3-way interactions	.303	.206

As Table 78 shows, in reading, the largest change in R^2 occurred with the entry of the parent education variable and the second largest change in R^2 occurred with the entry of the LEP status variable. In math, the largest change in R^2 also occurred with the entry of the parent education variable. The changes in R^2 with the entries of SES (Model 1) and LEP status (Model 3) were similar and considerably smaller than the change in R^2 attributable to parent education. In both reading and math, the additional increments in R^2 provided by the interactions were relatively unimportant. These results seem to indicate that parent education was relatively more important than LEP status in the models for reading and math. However, the changes in R^2 depend on the order of entry

(discussed in the next paragraph). Also, the importance of parent education was again overestimated by these models, because parent education was an ordinal variable, not an interval variable.

There were six possible orders in which the three predictor variables SES, LEP status, and parent education level could be entered into a regression model. The total R^2 obtained after all three variables were entered (.290 for reading, .196 for math) did not depend on the order of entry. However, the increments to R^2 did depend on the order of entry. Table 79 presents the incremental R^2s for the six possible orders.

Table 79

Site 2 Grade 9 Increments to R-squared for Reading and Math

	Predictors	R^2 Reading	R^2 Math
Order 1	SES	.046	.029
	SES, parent Ed	.219	.174
	SES, parent Ed, LEP	.290	.196
Order 2	SES	.046	.029
	SES, LEP	.190	.096
	SES, LEP, parent Ed	.290	.196
Order 3	LEP	.172	.082
	LEP, parent Ed	.285	.194
	LEP, parent Ed, SES	.290	.196
Order 4	LEP	.172	.082
	LEP, SES	.190	.096
	LEP, SES, parent Ed	.290	.196
Order 5	Parent Ed	.209	.170
	Parent Ed, LEP	.285	.194
	Parent Ed, LEP, SES	.290	.196
Order 6	Parent Ed	.209	.170
	Parent Ed, SES	.219	.174
	Parent Ed, SES, LEP	.290	.196

We see from Table 79 that of the three predictors, parent education has the strongest relationship with the reading and math NCEs, as the initial R^2 was highest when parent education was the first variable entered (Orders 5 and 6).

Also, when parent education was the second variable entered, the increment to R^2 was larger than the increment when another variable was the second variable entered. For example, with SES as the first variable entered in the reading model, including parent education (Order 1) raised the R^2 from .046 to .219, whereas including LEP status (Order 2) only raised the R^2 to .190. With LEP status as the first variable, entering parent education as the second variable (Order 3) raised the R^2 from .172 to .285, while entering SES (Order 4) only raised the R^2 to .190. Similarly, in these models LEP status adds more to the explanatory power than SES. For the reading models, the R^2 when entering LEP status first (Orders 3 and 4) was .172 compared with .046 for entering SES first (Orders 1 and 2). Comparing Orders 5 and 6, when LEP status was entered after parent education, the R^2 increased from .209 to .285, while the R^2 only increased to .219 for SES.

In summary, the three approaches gave somewhat conflicting results regarding the importance and relative importance of parent education, SES, and LEP status (and their interactions) as explanatory variables for SAT 9 reading and math NCE scores. The ANOVA reading model ranked LEP status as more important than parent education, while the ANOVA math model ranked parent education ahead of LEP status. Both ANOVA models underestimated the effect of parent education. The reading and math multiple regression models ranked parent education ahead of LEP status, but overestimated the importance of parent education. The change in R^2 approach ranked parent education ahead of LEP status, but also overestimated the importance of parent education. In all approaches, the two- and three-way interactions were significant, but did not add much to the R^2s. However, the interactions are of crucial importance in understanding the effects of these variables because the effects of one variable depend on the particular combinations of the other variables.

Similar trends held in the other Grade 9 tested subject areas of language, science, and social science. Using the change in R^2 approach, among the same three predictors parent education had the strongest relationship with the language, science, and social science SAT 9 scores, followed by LEP status, and SES had the weakest relationship. The overall R^2s were largest in reading and smallest in social science. The reading R^2s were considerably larger than those for the other tests. Table 80 summarizes the R^2s of the five tested subject areas for both the main-effects and the main-effects plus interactions models.

Table 80

Site 2 Grade 9 Models and R-Squares for the SAT 9 NCEs

Predictors	R-Square				
	Reading	Math	Language	Science	Social science
SES, LEP, parent Ed	.290	.196	.217	.202	.183
SES, LEP, parent Ed + interactions	.303	.206	.226	.212	.194

Focusing on the main-effects models for the SAT 9 NCEs, parent education always had the largest standardized regression coefficient, followed by LEP status and then by SES. Table 81 presents the absolute values of the standardized regression coefficients from the main-effects model for each predictor for each test. It is tempting to compare the magnitudes of these standardized coefficients across tests, but such comparisons can be misleading (see Pedhazur 1997).

Table 81

Site 2 Grade 9 Standardized Regression Coefficients for the SAT 9 NCEs

Predictor	Absolute value of standardized regression coefficient				
	Reading	Math	Language	Science	Social science
Parent Ed	.342	.344	.320	.319	.311
LEP status	.284	.159	.225	.197	.181
SES	.074	.052	.052	.062	.053

The results for the Grade 2 tests (reading, math, language, and spelling) were very similar. From both the change in R^2 and the standardized regression coefficient approaches, parent education seemed relatively most important in predicting/explaining the test NCEs, followed by LEP status. In reading and math, the Grade 2 R^2s were slightly smaller than the corresponding Grade 9 R^2s. However, in language, the Grade 2 R^2s were considerably larger than the Grade 9 R^2s. Table 82 and Table 83 replicate Table 80 and Table 81 for Grade 2.

Table 82

Site 2 Grade 2 Models and R-Squares for the SAT 9 NCEs

	R-Square			
Predictors	Reading	Math	Language	Spelling
SES, LEP, parent Ed	.283	.186	.258	.201
SES, LEP, parent Ed + interactions	.289	.192	.264	.204

Table 83

Site 2 Grade 2 Standardized Regression Coefficients for the SAT 9 NCEs

	Absolute value of standardized regression coefficient			
Predictor	Reading	Math	Language	Spelling
Parent Ed	.379	.354	.371	.343
LEP status	.204	.096	.184	.146
SES	.092	.072	.084	.068

Site 3

Multivariate analysis of variance. To test the level of significance of the differences between mean test scores for the LEP, SWD, and non-LEP/non-SWD populations, a single-factor MANOVA model was used. In this model, LEP and SWD status with four subgroup categories (LEP, SWD, LEP/SWD, non-LEP/non-SWD) was used as the independent variable, and subscale test scores (reading, science, and math) were used as the dependent variables. A similar model was used to test for differences between mean test scores for the non-LEP, accommodated LEP, and non-accommodated LEP populations. The results of these multivariate analyses of variance are summarized in Table 84 and Table 85, respectively. The statistics showing the overall significance of the models are reported in the first sections of Table 84 and Table 85. Differences between mean scores of the three content areas across the subgroups were statistically significant beyond the .01 nominal level (Wilks' Lambda for these models are 0.911 and 0.972, with the probability of a Type-I error of 0.000). It must be noted at this point, however, that the number of students in each of the subgroup categories of the independent variables varies considerably. Such large disproportionality may negatively impact the level of Type-I and Type-II errors

in ANOVA and MANOVA, even in the case of a moderate violation of assumptions. Because of this problem, prior to the application of the ANOVA and MANOVA models, we tested the assumption of normality and homogeneity of variance for the models used in this study. Test results indicate significant heterogeneity of subgroup variances. The results of the MANOVA models should therefore be interpreted with caution. However, the major findings of each of these models were consistent across grade levels, increasing our confidence in these results.

Table 84

Site 3 Grade 10 Multivariate Analysis of Variance Reading, Science and Math NCE Scores With LEP & SWD Status

	Overall effect of LEP & SWD status		
	Value	Approx. F	Sig. of F
Pillais	.0902	93.56	.000
Hotellings	.0974	97.88	.000
Wilks	.9106	96.05	.000

	Effect of LEP & SWD status for sub-tests (9,052 DF)			
	SS	MS	F	Sig. of F
Reading	183779.92	61259.97	262.14	.000
Science	126780.77	42260.26	151.01	.000
Math	106224.88	35408.29	127.48	.000

	Comparison of Individual Contrasts			
		Estimate	Standard error	Sig. of F
Reading	LEP only with non-LEP/SWD	-12.15	0.98	.000
	LEP/SWD with non-LEP/SWD	-19.65	4.24	.000
	LEP only with LEP/SWD	-7.50	4.35	.085
Science	LEP only with non-LEP/SWD	-9.74	1.08	.000
	LEP/SWD with non-LEP/SWD	-20.42	4.64	.000
	LEP only with LEP/SWD	-10.68	4.76	.025
Math	LEP only with non-LEP/SWD	-2.42	1.07	.024
	LEP/SWD with non-LEP/SWD	-18.61	4.63	.000
	LEP only with LEP/SWD	-16.19	4.74	.001

Table 84 also presents the results of univariate analysis of variance for each of the three dependent variables (reading, science, and math). In the second section, ANOVA results, including sum of squares, mean squares, *F*-ratios, and the associated Type-I error rates are reported for each of the three content areas. For reading, an *F*-ratio of 262.14 with a *p*-value of 0.000 indicated that the mean scores for the reading section of the SAT 9 differed significantly across the four subgroups of students. LEP and SWD students performed significantly lower than non-LEP/non-SWD students. A similar trend was observed for mean SAT 9 scores in science and math. In science, an *F*-ratio of 151.01 with a *p*-value of 0.000 indicated that the subgroups performed differently, and in math, an *F*-ratio of 127.48 with a *p*-value of 0.000 showed significant differences between the subgroups. However, the size of difference was largest in reading and smaller in science and math content areas. To compare the magnitude of difference (the strength of association), a *coefficient of determination* eta Square (see Kirk, 1995, p. 180) was computed for each of the three content areas. For reading Eta Square was 0.080, for science eta Square was 0.048 and for math, eta Square was 0.041. These results indicated that the impact of LEP/SWD status was strongest in reading, less so in science, and even less so in math. These findings suggest that the more language is involved, the larger the gap between the groups, particularly for LEP students.

Table 85

Site 3 Grade 10 Multivariate Analysis of Variance Reading, Science and Math NCE Scores With LEP & Accommodation Status

	Overall effect of LEP & SWD status		
	Value	Approx. F	Sig. of F
Pillais	.028	42.81	.000
Hotellings	.029	43.40	.000
Wilks	.972	43.11	.000

	Effect of LEP & SWD status for sub-tests (9,052 DF)			
	SS	MS	F	Sig. of F
Reading	44301.05	22150.53	88.93	.000
Science	28677.45	14338.73	49.33	.000
Math	3110.94	1555.47	5.38	.000

	Comparison of individual contrasts			
		Estimate	Standard error	Sig. of F
Reading	Non-acc LEP vs. non-LEP	-5.96	1.30	.000
	Acc LEP vs. non-LEP	-18.97	1.51	.000
Science	Non-acc LEP vs. non-LEP	-5.25	1.40	.000
	Acc LEP vs. non-LEP	-15.07	1.63	.000
Math	Non-acc LEP vs. non-LEP	-0.31	1.40	.823
	Acc LEP vs. non-LEP	-5.32	1.62	.001

Univariate analysis of variance for each of the three dependent variables (reading, science, and math) with the subgroup categories of non-LEP, accommodated LEP and non-accommodated LEP are presented in Table 85. In the second section, ANOVA results including sum of squares, mean squares, *F*-ratios, and the associated Type-I error rates are reported for each of the three content areas. For reading, an *F*-ratio of 88.93 with a *p*-value of 0.000 indicated that the mean scores for the reading section of the SAT 9 differed significantly across the three subgroups of students. Both accommodated and non-accommodated LEP students performed significantly lower than non-LEP students. A comparison of individual contrasts reveals that the estimate of the difference between accommodated LEP students and non-LEP students was especially large (-18.97). A similar trend was observed for mean SAT 9 scores in science. In science, an *F*-ratio of 49.33 with a *p*-value of 0.000 indicated that the

subgroups performed differently, and in math, an *F*-ratio of 5.38 with a *p*-value of 0.000 showed significant differences between the subgroups. However, in math a comparison of individual contrasts showed no significant difference between non-accommodated LEP students and non-LEP students. Once again the size of difference was largest in reading and smaller in the science and math content areas. For reading eta Square was 0.019, for science eta Square was 0.011 and for math, eta Square was 0.001. Similarly to the previous model, results indicate that the impact of LEP and accommodation status was strongest in reading, less so in science, and even less so in math.

Analyses for Grade 11

To check for consistency, the two multivariate models tested in Grade 10 were repeated with Grade 11. With the first model the statistical significance of the differences between performance of LEP/SWD and non-LEP/non-SWD students was tested. In this model, LEP and SWD status were used as the independent variable, and scores from the three content areas were used as the dependent variables. Table 86 summarizes the results of MANOVA for Grade 11. As the data in this table suggest, the results of multivariate analysis of variance for Grade 11 are consistent with those reported for Grade 10. In general, students obtained the lowest scores in reading and highest in math. Furthermore, the difference between the performances of LEP/SWD students with non-LEP/non-SWD students was smaller in math than in reading.

Statistics showing the overall significance of the MANOVA model are presented in the first section in Table 86. As these data indicate, the overall model was statistically significant well above the .01 nominal level (Wilks' Lambda = 0.878, F = 105.71, p = 0.000). These results indicate that there is a significant difference between the performance of LEP/SWD and non-LEP/non-SWD students across the three content areas.

Data in the second paragraph of Table 86 present univariate tests of significance. These data, which include sum of squares, mean squares, *F*-ratio, and *p*-values, indicated that the differences between LEP/SWD and non-LEP/non-SWD students were significant in all three content areas. For reading, the F-ratio was 243.18 with a *coefficient of determination* eta Square of .093; for science, the *F*-ratio was 134.75 with a eta Square of .054; and for math, the F-ratio was 117.05 with a eta Square of .047. However, as indicated earlier, the

magnitude of these differences decreased substantially from reading to science, and from science to math as is evident from the size of eta Square.

The multivariate and univariate statistics that are reported in the first two sections indicate that overall performance was different across the categories of LEP and SWD. Multiple comparisons were used to test the significance of differences between individual groups. The results of multiple comparison analyses are also presented. As the data in this part of the table indicate, the performance difference between LEP only and non-LEP/non-SWD students was significant (t = -13.95, p = 0.000). The difference between LEP/SWD and non-LEP/non-SWD was also significant (t = -3.04, p = .002). However, the difference between LEP only and LEP/SWD was not significant (t = -0.74, p = 0.459).

The trend of subgroup differences in science was consistent with the trend of subgroup differences in reading. There was a significant difference between LEP only and non-LEP/non-SWD (t = -9.76, p = 0.000). However, no significant difference was found between LEP only with LEP/SWD students. Unlike the results for reading and science, no significant difference was found between LEP only and non-LEP/non-SWD students in math. That is, LEP students performed the same as non-LEP students in math.

Table 86

Site 3 Grade 11 Multivariate Analysis of Variance Reading, Science, and Math NCE Scores with LEP & SWD Status

	Overall effect of LEP & SWD status		
	Value	Approx. F	Sig. of F
Pillais	.1253	103.03	.000
Hotellings	.1364	107.35	.000
Wilks	.8775	105.71	.000

	Effect of LEP & SWD status for sub-tests (7,089 DF)			
	SS	MS	F	Sig. of F
Reading	221423.96	73807.99	243.18	.000
Science	134835.02	44945.01	134.75	.000
Math	149812.56	49937.52	117.05	.000

		Comparison of individual contrasts		
		Estimate	Standard error	Sig. of F
Reading	LEP only with non-LEP/SWD	-16.31	1.17	.000
	LEP/SWD with non-LEP/SWD	-21.64	7.11	.002
	LEP only with LEP/SWD	-5.33	7.20	.459
Science	LEP only with non-LEP/SWD	-11.96	1.23	.000
	LEP/SWD with non-LEP/SWD	-15.00	7.46	.044
	LEP only with LEP/SWD	-3.04	7.55	.687
Math	LEP only with non-LEP/SWD	0.86	1.39	.537
	LEP/SWD with non-LEP/SWD	-18.84	8.44	.026
	LEP only with LEP/SWD	-19.69	8.54	.021

Table 87 presents the results for a model that tests the statistical significance of the differences between performance of non-LEP, accommodated LEP, and non-accommodated LEP students. In this model, LEP and accommodation status were used as the independent variable, and scores from the three content areas were used as the dependent variables. Table 87 summarizes the results of MANOVA for Grade 11. The results of multivariate analysis of variance for Grade 11 were again consistent with those reported for

Grade 10. In general, students obtained the lowest scores in reading and highest in math. Furthermore, the difference between the performances of non-LEP, accommodated LEP, and non-accommodated LEP students was smaller in math than in reading.

Statistics showing the overall significance of the MANOVA model are presented in the first section in Table 87. The overall model was statistically significant well above the .01 nominal level (Wilks' Lambda = 0.9418, F = 73.28, p = 0.000). These results indicated that there was a significant difference between the performance of accommodated LEP students, non-accommodated LEP students, and non-LEP students across the three content areas.

Data in the second section present univariate tests of significance. These data, which include sum of squares, mean squares, *F*-ratio, and *p*-values indicate that the differences between accommodated LEP students, non-accommodated LEP students, and non-LEP students was significant in reading and science. For reading, the F-ratio was 101.02 with a *coefficient of determination* eta Square of .028; for science, the *F*-ratio was 47.42 with a eta Square of .013. In math there were no significant differences among the three LEP/accommodation status subgroup categories, F = 0.52 and eta Square = .000. As the data suggest, the multivariate and univariate statistics that are reported in the first two sections indicate that overall performance was different across the categories of LEP and accommodation. Multiple comparisons were used to test the significance of differences between individual groups. The results of multiple comparison analyses were also presented. The results are similar to those we presented for Grade 10. Both accommodated LEP students and non-accommodated LEP performed significantly lower than non-LEP students (p = .000) in both reading and science. A comparison of individual contrasts shows that the largest contrast (-22.97) was the estimate of the difference between accommodated LEP students and non-LEP students in reading. As indicated earlier, there were no differences among the three subcategories of the LEP and accommodation status variable in math.

Table 87

Site 3 Grade 11 Multivariate Analysis of Variance Reading, Science and Math NCE Scores With LEP & Accommodation Status

	Overall effect of LEP & accommodation status		
	Value	Approx. F	Sig. of F
Pillais	.059	72.17	.000
Hotellings	.063	74.39	.000
Wilks	.941	73.28	.000

	Effect of LEP & accommodation status for sub-tests (7,089 DF)			
	SS	MS	F	Sig. of F
Reading	65745.71	32872.85	101.02	.000
Science	32989.39	16494.70	47.42	.000
Math	463.19	231.60	0.52	.596

		Comparison of individual contrasts		
		Estimate	Standard error	Sig. of F
Reading	Non-acc. LEP vs. non-LEP	-8.50	1.63	.000
	Acc. LEP vs. non-LEP	-22.97	1.73	.000
Science	Non-acc. LEP vs. non-LEP	-6.92	1.68	.000
	Acc. LEP vs. non-LEP	-15.88	1.79	.000
Math	Non-acc. LEP vs. non-LEP	1.51	1.91	.428
	Acc. LEP vs. non-LEP	1.32	2.02	.515

Site 4

Canonical correlation analysis. Because there were several related performance indicators in this study, we decided to use these indicators in a multivariate model. We tried to examine the relationship between performance in math and science and background variables, particularly with language background variables. We used a canonical correlation model to link the two sets of variables: (a) the content-based (performance) measures, and (b) the background variables, including the language background variables. The performance variables that were included in the canonical models were reading, math computational, math analytical, and grade point average (GPA). The background variables that were included in the models were: LEP status (categorical), SES (four ordered categories), gender (categorical), and language spoken at home (three ordered categories).

Principal components analyses were performed on these variables. Both sets of variables were included in one model. The purpose of components analyses was to find out how much variance the sets of variables share with each other. Table 88 presents the results of components analyses in which we included all the variables mentioned above.

Table 88

Site 4 Grade 8 Rotated Factor Matrix for Performance and Background Variables

	Factor loadings	
Variable name	Factor 1	Factor 2
Set 1, performance variables		
Reading	0.86	
Math computational	0.85	
Math analytical	0.89	
GPA	0.74	
Set 2, background variables		
LEP status (categorical)		0.83
SES (ordered categories)	-0.39	
Gender (categorical)		
Language spoken at home (ordered categories)		0.86
Eigenvalue	3.09	1.52
Percent of shared variance explained	38.6	19.0

Note. Only factor loadings of .33 or greater have been reported.

Table 89 presents the results of canonical correlation analyses for examining the relationship between the two sets of variables, the performance variables, and the background variables. The model yielded one significant function (Wilks' Lambda = .75, p = 0.000) and explained 54% of the variance in the dependent variables. The first canonical correlation was .403, which means that the first canonical variate pair explains 16.3 % of the shared variance between the two sets of variables.

Correlations and standardized coefficients between the first canonical function and the variables in the first and second sets are reported in Table 89. These correlation coefficients suggest that the first set and the second set of

variables were related. The first set of variables was highly correlated with the canonical variable. The correlation was .95 between reading and the canonical variate, which was the largest; .71 between GPA and the canonical variate; .67 between math analytical and the canonical variate; and .54 between math computational and the canonical variate. The standardized coefficients can be used to examine the relative influence of each variable in the model. The standardized coefficient for reading with the first canonical function was .92. This is large in comparison to the standardized coefficients for math computational (-.21), math analytical (-.28), and GPA (.37). This indicates that among the dependent variables, reading had the strongest influence on the first canonical covariate. We can infer that reading performance is more dependent upon the set of independent variables than is math computational, math analytical, or GPA.

In the second set, the correlations of the variables with the canonical variate were not as high as in the first set. The highest correlation was between SES and the canonical variate (r = -.64). The next highest correlation was between LEP status and the canonical variate (r = -.61). The standardized coefficients indicate that SES had the largest impact on the canonical variate. The standardized coefficient for SES was -.60. Gender and LEP status also impacted the canonical variate, with respective standardized coefficients of -.50 and -.49. Language spoken at home had little contribution to the canonical variate, as indicated by its standardized coefficient of -.11.

In general, the results of multivariate canonical correlation analyses confirm our earlier findings that suggest that language background has significant impact on performance. This impact appears to be most pronounced in performance areas that require large language demands, such as reading.

Table 89

Site 4 Grade 8, 1996. Correlations, Standardized Canonical Coefficients, and Canonical Correlation Between Performance and Background Variables

	First canonical variate	
Variable	Correlation	Coefficient
Set 1 (dependent variables)		
Reading	0.95	0.92
Math computational	0.54	-0.21
Math analytical	0.67	-0.28
GPA	0.71	0.37
Set 2 (independent variables)		
LEP status (categorical)	-0.61	-0.49
SES (ordered categories)	-0.64	-0.60
Gender (categorical)	-0.54	-0.50
Language spoken at home	-0.40	-0.11
Percent of variance among performance variables explained	53.78	
Canonical correlation	0.403	

In order to better understand the joint effects of LEP status and SES on the SAT 9 NCE scores we employed three related approaches:

1. Two-way factorial ANOVA models;
2. Multiple regression models;
3. Change in R^2 with nested multiple regression models.

We examined two two-way factorial ANOVA models with Grade 8 reading NCE and math total NCE as the outcome variables. The two explanatory variables in each model were LEP status (an indicator variable) and SES. Table 90 and Table 91 display the cell means for reading and math, respectively. Both the reading and math models were significant at $p<.0001$. In the reading model, the LEP by SES interaction was significant ($p<.0001$), indicating that the effect of SES depends on the level of LEP status and the effect of LEP status depends on the level of SES. In the math model, the LEP by SES interaction was not significant ($p = .274$), while both main effects were significant ($p<.0001$). These effects are further described in the following paragraphs.

Table 90

Site 4 Grade 8 Reading NCE Means by SES and LEP Status

	LEP Status					
	LEP			Non-LEP		
FRL (SES)	Mean	*SD*	*N*	Mean	*SD*	*N*
None	22.48	17.56	316	46.59	21.81	7900
Reduced price	21.91	17.02	61	39.41	20.72	970
Free	18.34	14.63	211	35.03	21.07	1358
AFDC	16.47	14.69	104	32.10	20.51	1564
TOTAL	20.26	16.39	692	42.75	22.21	11792

Table 91

Site 4 Grade 8 Math NCE Means by SES and LEP Status

	LEP Status					
	LEP			Non-LEP		
FRL (SES)	Mean	*SD*	*N*	Mean	*SD*	*N*
None	39.98	21.02	314	50.93	21.35	7817
Reduced price	35.52	15.95	63	45.16	20.03	963
Free	33.35	15.08	207	40.80	18.49	1344
AFDC	29.49	14.88	103	37.46	17.14	1526
TOTAL	36.00	18.48	687	47.52	21.06	11650

First, we consider the reading model. Figure 33 displays the cell means for the reading model. The gap between LEP and non-LEP students depended on the level of SES, with the largest gap (24.2 NCE points) occurring in the "None" level. This gap decreased across the "Reduced-price" (17.5) and "Free" (16.7) levels, and was smallest in the Aid to Families with Dependent Children (AFDC) (15.6) level. In the LEP student group, the reading NCE means decreased slightly across the SES levels, from a high of 22.48 in the "None" level to a low of 16.47 in the "AFDC" level. The trend of decreasing NCE means was similar among the non-LEP students, but the decreases were more dramatic, from a high of 46.59 in the "None" level to a low of 32.10 in the "AFDC" level. Averaging across the four SES levels, the reading mean for the LEP group was 20.26, considerably lower than the reading mean of 42.75 for the non-LEP group. Averaging across the two LEP status levels, the means for the four levels of SES

decreased from 45.67 (SD = 22.15, N = 8216) for "None", to 38.38 (SD = 20.92, N = 1031) for "Reduced-price", to 32.79 (SD = 21.10, N = 1569) for "Free", to 31.12 (SD = 20.55, N = 1668) for the "AFDC" level.

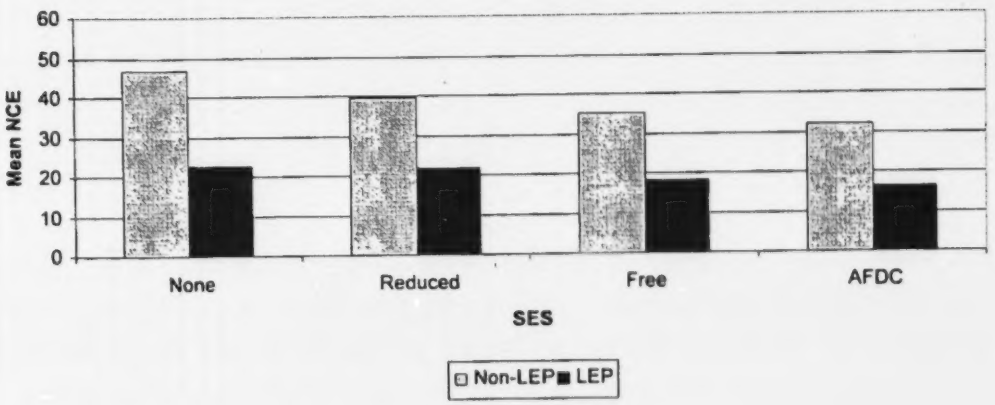

Figure 33. Site 4 Grade 8 Reading NCE by SES and LEP status.

Figure 34 presents the math NCE cell means for the LEP and SES groupings. The gap between LEP and non-LEP students was relatively similar across the levels of SES, ranging from a high of about 11 points in the "None" level to a low of about 7.5 points in the "Free" level—the differences in these gaps were within sampling error. Within the LEP student group, the math NCE means decreased from a high of 39.98 in the "None" level to a low of 29.49 in the "AFDC" level, a decrease of about 10.5 points. The trend was similar in the non-LEP group, with the math mean decreasing from a high of 50.93 in the "None" level to a low of 37.46 in the "AFDC" level, an overall decrease of about 13.5 points. The overall LEP math mean NCE was 36.00 (SD = 18.48, N = 687), about 11.5 points below the non-LEP mean of 47.52 (SD = 21.06, N = 11650). Averaging across the two LEP groups, the SES level means decreased from 50.50 (SD = 21.44, N = 8131) for "None", to 44.47 (SD = 19.94, N = 1026) for "Reduced-price", to 39.81 (SD = 18.24, N = 1551) for "Free", and to 36.96 (SD = 17.11, N = 1629) for "AFDC."

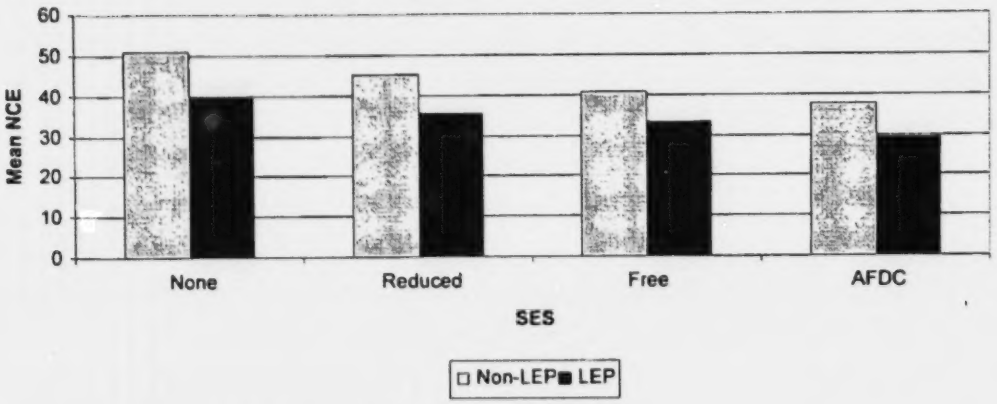

Figure 34. Site 4 Grade 8 Math NCE by SES and LEP status.

The strength of association measure *eta-squared* was calculated for each effect for both the reading and math models. The results are presented in Table 92. In the reading model, LEP status had the strongest association (.026) with the NCE mean, followed by SES (.008), and then by the LEP by SES level interaction (.002). In the math model, SES level was stronger than LEP status (.011 versus .007), while the interaction had no effect.

Table 92

Site 4 Grade 8 Strength of Association & Standardized Regression Coefficients (Beta)

	Reading		Math	
Effect	Eta-squared	Beta	Eta-squared	Beta
LEP status	.026	-.273	.007	-.132
SES level	.008	-.253	.011	-.246
Interaction	.002	.076	.000	.033

To summarize the ANOVA models, SES level, LEP status, and their interactions each explained a significant portion of the reading NCE variance. LEP status was more strongly associated with the reading NCE means than SES level. In math, however, the interaction of SES level and LEP status was not significant, and SES level was more strongly associated with mean NCE than

LEP status. Because these ANOVA models ignore the ordinal nature of the SES level variable, the impact of SES level on the reading and math NCEs was underestimated by these models.

A second approach to assessing the impact of the explanatory variables SES level and LEP status on the NCEs is to create multiple regression (MR) models with SES level and LEP status and their interaction as predictors and reading and math NCE as the outcome variables. However, because such MR models treat SES as an interval variable, these models will overestimate the effect of SES (SES level is really an ordinal variable).

The MR model for predicting reading NCE was significant, with $p<.0001$ and $R^2 = .113$ (i.e., a little more than 11% of the reading NCE variance was explained by the predictors). The model for math NCE was also significant, with $p<.0001$ and $R^2 = .074$; i.e. a little more than 7% of the math NCE variance was explained by the model predictors. Within each model, the absolute values of the standardized regression coefficients (betas) rank the predictors as to their relative importance. These betas are presented in Table 92. In reading, LEP status and SES level were of relatively equal importance. In math, SES level was relatively more important than LEP status. However, the MR models overestimate the importance of SES.

A third way of assessing the effects of LEP status and SES on the NCEs is to create a sequence of nested MR models and measure the change in R^2 from model to model. The predictor variables LEP status and SES can be entered into a model in two orders, with either one being entered first. For each order, a sequence of three regression models was created. In the first order, for the first model SES was the single predictor; the second model contained SES and LEP status as predictors; the third model had SES, LEP status, and their interaction as predictors. In the second order, the roles of SES and LEP were reversed. Table 93 presents the results of these models for the reading and math NCEs.

From Table 93, we see that the final reading model was better than the final math model, with $R^2 = .113$ for reading versus .074 for math. In reading, and especially in math, in the single predictor models, SES was more strongly related to the NCEs than LEP status; the R^2s for the single predictor models were .069 and .063 with SES as predictor versus .052 and .016 for LEP status as the predictor. For reading, with SES already in the model (Order 1), the R^2

increased .042 (from .069 to .111) with the entry of LEP status into the model. In math, with SES already in the model, R^2 increased only .011 (from .063 to .074) when LEP status was entered. Thus, with SES already in the model, the entry of LEP status added considerably to the R^2 in reading, but did not add much in math. In Order 2, with LEP status already in the model, the entry of SES added considerably to R^2 for both reading and math. The interaction added little: .002 to R^2 in reading and nothing to R^2 in math. In summary, we see that SES was important in both the reading and math models, while LEP status was far more important in the reading than in the math models. Also, in reading, SES was slightly more important than LEP status, while in math, SES was more important. These results are very similar to the MR beta results discussed previously.

Table 93

Site 4 Grade 8 Increments to R-squared for Reading and Math

Predictors	R^2 Reading	R^2 Math
Order 1		
SES	.069	.063
SES, LEP	.111	.074
SES, LEP, interaction	.113	.074
Order 2		
LEP	.052	.016
LEP, SES	.111	.074
LEP, SES, interaction	.113	.074

Comparing the ANOVA and regression approaches, we have somewhat conflicting results regarding the importance and relative importance of LEP status and SES. The ANOVA models, which underestimate the effects of SES, indicate that in reading, LEP status is more important than SES, while in math, SES is more important than LEP status. The regression models, which overestimate the effects of SES, indicate in reading LEP status is slightly more important than SES, whereas, in math, SES is far more important then LEP status. The truth lies somewhere in between these indications.

Structural Modeling

The results of our analyses on the SAT 9 item-level data that we reported earlier suggested that language factors may introduce another source of measurement error in the measurement model for LEP students. Internal consistency coefficients were lower for LEP students. There were large differences in the performance of LEP and non-LEP students that were apparent, especially with respect to the reading items.

Due to the impact of language factors, the intercorrelation between individual test items, the correlation between items and total test score (internal validity coefficient), and the correlation between item score and total test score with the external criteria (achievement data) may be different for LEP and non-LEP students. That is, these relationships may be stronger for non-LEP students. To further examine the hypothesis of differences between LEP and non-LEP students on the structural relationship of the test items, a series of confirmatory factor models were created in Sites 1 and 3. Fit indices were compared across LEP and non-LEP groups. The results generally indicated that the relationships between individual items, items with the total test score, and items with the external criteria were higher for non-LEP than for LEP students. We will present a more detailed discussion of the results of these analyses in the next two sections.

Site 2

Simple structural confirmatory factor models. To compare within-test and cross-test structural relationships between LEP and non-LEP students, a series of simple structure confirmatory models were created. In creating these models, test items in each of the three content areas (reading, science, and math) were grouped as "parcels."[2] Several item-parcels were constructed for each test. Items-parcels were used as measured variables, and one latent variable was created to represent each content area. Correlation coefficients between the content-based latent variables were then estimated. Reading tests for Grade 9 had 52 items. Four parcels (measured variables) and a reading latent variable based on the four parcels were constructed. Similarly, four parcels and a science latent variable were constructed from the 40-

[2] For a detailed description of the item-parcel concept and item-parcel construction, see Abedi, Lord, & Hofstetter, 1997.

item science tests for Grade 9. A math latent variable based on four parcels from the 48-item math tests in Grade 9 was also created.

Figure 35 presents item-parcels and latent variables for reading, math, and science and the correlation between the reading, math, and science latent variables. The 52 reading items were grouped into four parcels. Each parcel was constructed to systematically contain heterogeneous items based on item difficulty. Through this process each parcel contained easy, moderately difficult, and difficult items. The result was a set of homogenous parcels. A reading latent variable was constructed based on these four parcels. Similarly, item parcels and latent variables for science and math were created from the 40 science items and 48 math items through the same process. Correlation between the reading, math, and science latent variables were estimated. Models were tested on randomly selected sample populations to demonstrate the consistency of the results. In Grade 7, a similar structural model was created for content areas reading, math problem solving, and math procedures. Finally, a random sample selected for even sample sizes of non-LEP and LEP students was tested to demonstrate that differences in the results were not due to uneven sample sizes.

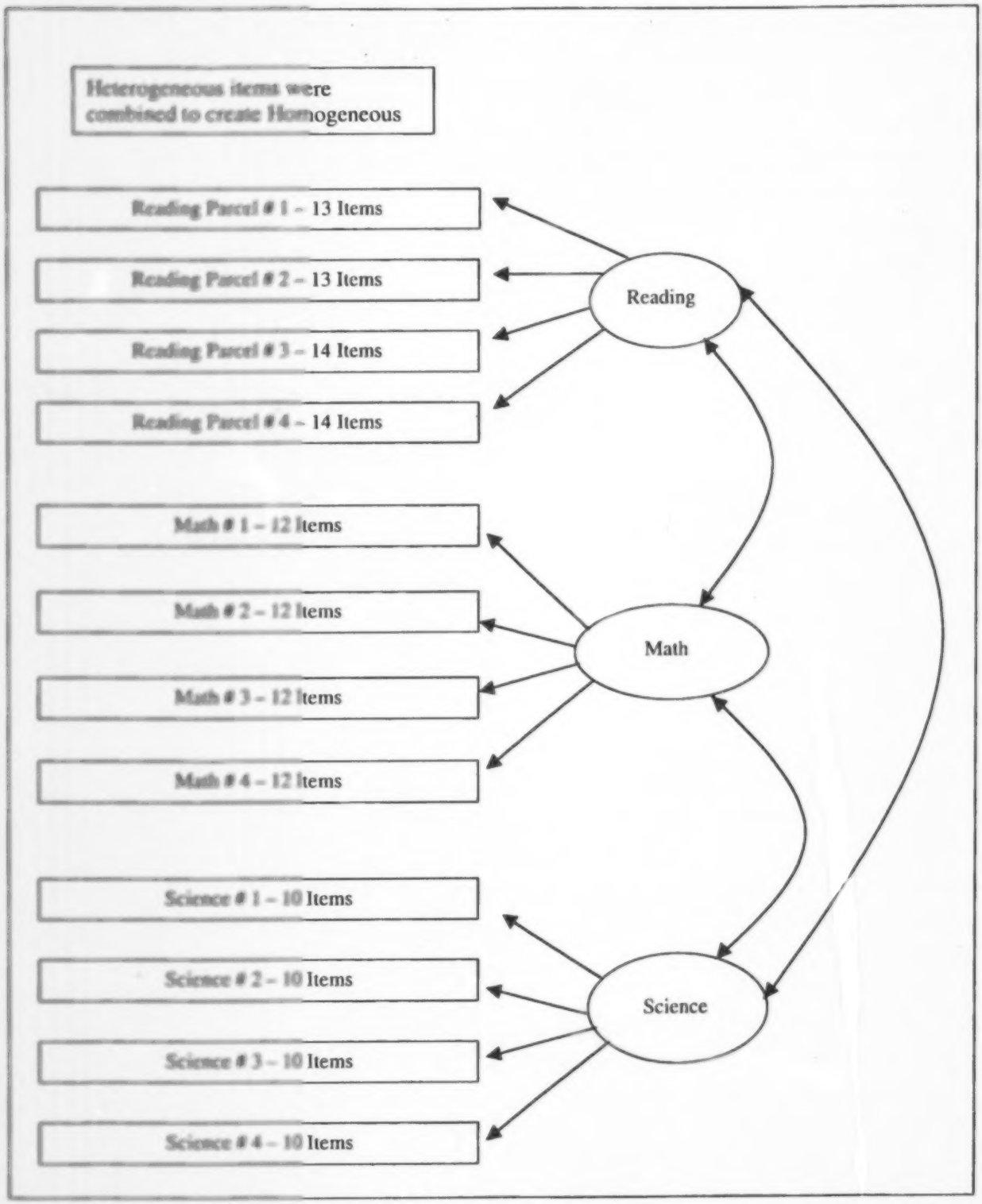
Heterogeneous items were combined to create Homogeneous
Reading Parcel # 1 – 13 Items
Reading Parcel # 2 – 13 Items
Reading Parcel # 3 – 14 Items
Reading Parcel # 4 – 14 Items
Reading
Math # 1 – 12 Items
Math # 2 – 12 Items
Math # 3 – 12 Items
Math # 4 – 12 Items
Math
Science # 1 – 10 Items
Science # 2 – 10 Items
Science # 3 – 10 Items
Science # 4 – 10 Items
Science

Figure 35. Site 2 Grade 9 simple structural equations model.

Table 94 shows the results of the structural models run for Grade 9 and Table 95 presents similar information for Grade 7. In Table 96, the Grade 7 model was analyzed for a sample selected with even numbers of non-LEP and LEP students. The results of these structural models presented in Table 94, Table 95, and Table 96 were consistent for all the models tested in this site. Correlations of item parcels to the latent factors were consistently lower for LEP students than for non-LEP students. This finding was true for all parcels, regardless of which grade or which sample of the population was tested. For example, in Grade 9, for LEP students the correlation for the four reading parcels ranged from a low of .719 to a high of .779 across the two samples, as shown in Table 94. In comparison, for non-LEP students the correlation ranged from a low of .832 to a high of .858. The item parcel correlations were also larger for non-LEP students than for LEP students in math and science. Again these results were consistent in each sample. The paired correlations between the latent factors were also larger for non-LEP students than they were for LEP students. This gap in latent factor correlations between non-LEP and LEP students was especially large when there was a bigger language demand difference in the latent factors. For example, in the Grade 9 sample #1, the correlation between latent factors for math and reading for non-LEP students was .782, compared to just .645 for LEP students. When comparing the latent factor correlations between reading and science from the same population, the correlation was still larger for non-LEP students (.837) than for LEP students (.806), but the gap between the correlations decreased. This is likely due to a larger language demand difference between the reading and math tests, as compared to the reading and science tests. Once again, this finding remained consistent for sample #2 in Grade 9 and for both samples in Grade 7 (see Table 95). A representative sample of non-LEP students of comparable size to the LEP population was selected. Table 96 shows the results of structural models for this sample. There were no changes in the previous trends. Item parcel correlations and correlations between the latent factors remain larger for non-LEP students then for LEP students. Multiple group structural models were run to test whether the differences between non-LEP and LEP students mentioned above were significant. There was significant invariance for all constraints tested at the $p<.05$ level.

These results (Table 94, Table 95, and Table 96) indicate that:

1. Findings from the cross-validation samples are very consistent and provide evidence for the validity of analyses.

2. Correlations between parcel scores and the content-based latent variables are generally lower for LEP students.
3. Correlations between the content-based latent variables are generally lower for LEP students.
4. These results are all indicative of a possible language factor as a source of measurement error for LEP students.

Table 94

Site 2 Grade 9 SAT 9 Reading and Math and Science Structural Modeling Results (DF = 51)

	Non-LEP (*N* = 22,782)		LEP (*N* = 4,872)	
	Sample #1	Sample #2	Sample #1	Sample #2
Goodness of fit				
Chi square	488	446	152	158
NFI	.997	.998	.992	.992
NNFI	.997	.997	.993	.993
CFI	.998	.998	.995	.995
Factor loadings				
Reading Comp.				
Parcel 1	.852	.853	.723	.719
Parcel 2	.841	.844	.734	.739
Parcel 3	.835	.832	.766	.779
Parcel 4	.858	.858	.763	.760
Math factor				
Parcel 1	.818	.821	.704	.699
Parcel 2	.862	.860	.770	.789
Parcel 3	.843	.843	.713	.733
Parcel 4	.797	.796	.657	.674
Science factor				
Parcel 1	.678	.681	.468	477
Parcel 2	.679	.676	.534	.531
Parcel 3	.739	.733	.544	.532
Parcel 4	.734	.736	.617	.614
Factor correlation				
Reading vs. math	.782	.779	.645	.674
Reading vs. science	.837	.839	.806	.802
Science vs. math	.870	.864	.796	.789

Note. There was significant invariance for all constraints tested with multiple group model (Non-LEP/LEP).

Table 95

Site 2 Grade 7 SAT 9 Reading and Math (Problem Solving & Procedures) Structural Modeling Results (DF = 51)

	Non-LEP (N = 25,716)		LEP (N = 6,546)	
	Sample #1	Sample #2	Sample #1	Sample #2
Goodness of fit				
Chi square	495	531	184	156
NFI	.998	.998	.995	.996
NNFI	.998	.997	.995	.996
CFI	.998	.998	.996	.997
Factor loadings				
Reading Comp.				
Parcel 1	.842	.846	.763	.770
Parcel 2	.879	.879	.800	.790
Parcel 3	.840	.840	.795	.798
Parcel 4	.858	.860	.816	.817
Math Prob. solving				
Parcel 1	.832	.836	.729	.726
Parcel 2	.833	.835	.696	.710
Parcel 3	.845	.846	.705	.711
Parcel 4	.850	.853	.706	.710
Math procedures				
Parcel 1	.817	.822	.718	.739
Parcel 2	.783	.783	.667	.684
Parcel 3	.855	.856	.769	.765
Parcel 4	.817	.815	.714	.719
Factor correlation				
Reading vs. math PS	.809	.810	.720	.718
Reading vs. math Pr	.733	.736	.601	.606
Math PS vs. math Pr	.921	.918	.874	.883

Note. There was significant invariance for all constraints tested with multiple group model (Non-LEP/LEP).

Table 96

Site 2 Grade 7 SAT 9 Reading and Math (Problem Solving & Procedures) Structural Modeling Results (DF = 51) Selected for Even Sample Sizes

	Non-LEP (N = 25,716)		LEP (N = 6,546)	
	Sample #1	Sample #2	Sample #1	Sample #2
Goodness of fit				
Chi square	204	143	184	156
NFI	.997	.998	.995	.996
NNFI	.997	.998	.995	.996
CFI	.998	.998	.996	.997
Factor loadings				
Reading Comp.				
Parcel 1	.851	.852	.763	.770
Parcel 2	.879	.882	.800	.790
Parcel 3	.837	.839	.795	.798
Parcel 4	.858	.863	.816	.817
Math Prob. solving				
Parcel 1	.842	.830	.729	.726
Parcel 2	.838	.838	.696	.710
Parcel 3	.856	.842	.705	.711
Math procedures				
Parcel 1	.830	.818	.718	.739
Parcel 2	.786	.790	.667	.684
Parcel 3	.859	.856	.769	.765
Parcel 4	.815	.813	.714	.719
Factor correlation				
Reading vs. math PS	.809	.802	.720	.718
Reading vs. math Pr	.738	.722	.601	.606
Math PS vs. math Pr	.919	.923	.874	.883

Note. There was significant invariance for all constraints tested with multiple group model (Non-LEP/LEP).

Site 3

Simple structural confirmatory factor models. To compare within-test and cross-test structural relationships between LEP and non-LEP students, a series of simple structure confirmatory models were created. In creating these models, test items in each of the three content areas (reading, science, and math) were grouped as "parcels." Several item-parcels were constructed for each test. Item-parcels were used as measured variables, and one latent variable was created to represent each content area. Correlation coefficients between the content-based latent variables were then estimated.

From the reading tests for Grades 10 and 11, which had 54 items, five parcels (measured variables) and a reading latent variable were constructed. Similarly, four parcels and a science latent variable were constructed from the 40-item science tests, and a math latent variable based on five parcels from the 48-item math tests was also created.

Figure 36 presents item-parcels and latent variables for reading and science and the correlation between the reading and science latent variables. The 54 reading items were grouped into five parcels (items 1-11 were grouped into parcel 1, items 12-22 were grouped into parcel 2, and so on). A reading latent variable was constructed based on the five parcels and was labeled as F1. Similarly, four parcels were created from the 40 science items and a science latent variable was created, labeled as F2. Correlation between the reading and science latent variables was estimated.

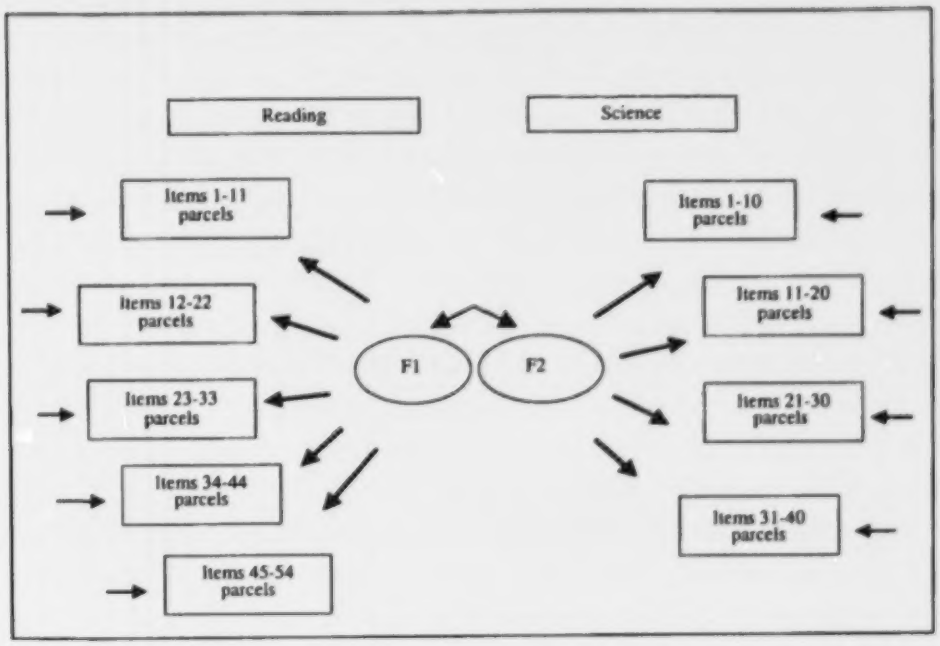

Figure 36. Site 3 item-parcels and latent variables for reading and science and their correlation.

Table 97 and Table 98 summarize the results of our analyses for the model that was presented in Figure 36. To do a cross-validation study, we divided the entire population of students into two groups: (a) the group called "even cases" consisted of students who were assigned even serial numbers, and (b) the group called "odd cases" consisted of students who were assigned odd serial numbers. Because student names were ordered alphabetically, the assignment of subjects to the two groups was considered systematic random sampling.

Table 97

Site 3 Grade 10 SAT 9 Reading and Science Structural Modeling Results (DF = 24)

	All cases (N = 9,182)	Even cases (N = 4,591)	Odd cases (N = 4,591)	Non-LEP (N = 8,918)	LEP (N = 264)
Goodness of fit					
Chi square	2040	966	1098	1940	106
NFI	.931	.935	.925	.932	.831
NNFI	.897	.904	.890	.899	.792
CFI	.931	.936	.927	.933	.861
Factor loadings					
Reading variables					
Parcels 1	.687	.695	.679	.685	.628
Parcels 2	.692	.698	.687	.687	.697
Parcels 3	.745	.738	.751	.741	.724
Parcels 4	.822	.823	.821	.823	.712
Parcels 5	.689	.688	.691	.691	.550
Science variables					
Parcels 1	.667	.671	.662	.665	.623
Parcels 2	.564	.554	.575	.565	.449
Parcels 3	.649	.648	.650	.652	.547
Parcels 4	.453	.451	.456	.461	.262
Factor correlation					
Reading vs. math	.811	.824	.797	.809	.815

In Table 97, we report the goodness of fit statistics, correlation coefficients between the items parcels and the latent variables (factor loadings), and the correlation between the two latent variables (reading and math). These statistics are reported separately for the entire group of students in Grade 10, for the two cross-validation subgroups, and for LEP and non-LEP students. Statistics under the goodness of fit section include Chi-square, Normed Fit Index (NFI), Non-Normed Fit Index (NNFI), and Comparative Fit Index (CFI) (see Bentler, 1992; Bentler & Bonett, 1980).

As the data in Table 97 suggest, the fit statistics for the entire group were very similar to those reported for the cross-validation subgroups (even and odd cases) and to those reported for the non-LEP groups. For example, the NFI was .931 for Grade 10: .935 for the even cases, .925 for the odd cases, and .932 for the non-LEP

group. However, for the LEP group, the NFI dropped to .831, which indicates that for LEP students, the fit is not as good as for the non-LEP group or for the entire group. This may be due to the fact that for LEP students, the language factor may introduce a new source of bias (measurement error), as we speculated earlier.

Additionally, Table 97 reports correlations between the parcel scores and the reading and science latent variables (factor loadings) for all of Grade 10, for the two cross-validation subgroups, and for the non-LEP and LEP groups. These correlations were very similar for all groups except for the non-LEP group. For the non-LEP group, the correlations were generally lower. For the entire group, for the cross-validation groups, and for the non-LEP students, the correlations ranged from .451 to .823, with an average of .663. For the LEP group, the correlations ranged from .262 to .724, with an average of .577. These results indicate that the latent models do not provide as strong a structural relationship for the LEP group as for the non-LEP groups. This may be partly due to impact of language factors on the measurement.

Table 97 also reports correlation coefficients between the factors (latent variables). These correlations were very similar across the subgroups including the LEP subgroup in this table (Grade 10, reading and math). However, in other cases, these correlations followed the same pattern of lower relationship for LEP students (see, for example, Table 98, Table 99, and Table 100).

Table 98 presents similar results for Grade 11. The results obtained for Grade 11 were consistent with those reported for Grade 10. Fit index statistics and factor loadings were generally lower for LEP groups.

Table 98

Site 3 Grade 11 SAT 9 Reading and Science Structural Modeling Results (DF = 24)

	All cases (N = 7,176)	Even cases (N = 3,588)	Odd cases (N = 3,588)	Non-LEP (N = 6,932)	LEP (N = 244)
Goodness of fit					
Chi Square	1786	943	870	1675	81
NFI	.931	.926	.934	.932	.877
NNFI	.898	.891	.904	.900	.862
CFI	.932	.928	.936	.933	.908
Factor loadings					
Reading variables					
Parcels 1	.733	.720	.745	.723	.761
Parcels 2	.735	.730	.741	.727	.713
Parcels 3	.784	.779	.789	.778	.782
Parcels 4	.817	.822	.812	.816	.730
Parcels 5	.633	.622	.644	.636	.435
Science variables					
Parcels 1	.712	.719	.705	.709	.660
Parcels 2	.695	.696	.695	.701	.581
Parcels 3	.641	.628	.654	.644	.492
Parcels 4	.450	.428	.470	.455	.257
Factor correlation					
Reading vs. math	.796	.796	.795	.797	.791

Similar results are presented in Table 99 and Table 100 for content areas reading and math. Table 99 presents the results for Grade 10 and Table 100 presents for Grade 11.

Table 99

Site 3 Grade 10 SAT 9 Reading and Math Structural Modeling Results (DF = 32)

	All cases (N = 9,250)	Even cases (N = 4,625)	Odd cases (N = 4,625)	Non-LEP (N = 8,947)	LEP (N = 303)
Goodness of fit					
Chi square	2875	1490	1407	2736	155
NFI	.919	.915	.921	.920	.861
NNFI	.887	.883	.892	.888	.838
CFI	.920	.917	.923	.920	.885
Factor loadings					
Reading variables					
Parcels 1	.682	.676	.689	.678	.644
Parcels 2	.689	.688	.689	.682	.675
Parcels 3	.744	.733	.755	.738	.752
Parcels 4	.828	.826	.831	.827	.751
Parcels 5	.696	.692	.700	.695	.615
Math variables					
Parcels 1	.733	.726	.740	.736	.723
Parcels 2	.659	.663	.655	.655	.800
Parcels 3	.630	.642	.618	.629	.615
Parcels 4	.727	.721	.734	.725	.749
Parcels 5	.393	.409	.378	.390	.432
Factor correlation					
Reading vs. math	.702	.700	.704	.721	.485

Table 100

Site 3 Grade 11 SAT 9 Reading and Math Structural Modeling Results (DF = 32)

	All cases (N = 7,313)	Even cases (N = 4,556)	Odd cases (N = 4,557)	Non-LEP (N = 7,045)	LEP (N = 268)
Goodness of fit					
Chi square	2032	971	1115	1929	77
NFI	.940	.943	.935	.941	.924
NNFI	.917	.922	.911	.918	.934
CFI	.941	.945	.937	.942	.953
Factor loadings					
Reading variables					
Parcels 1	.732	.723	.741	.720	.769
Parcels 2	.740	.744	.735	.729	.742
Parcels 3	.782	.783	.782	.773	.782
Parcels 4	.818	.830	.806	.818	.724
Parcels 5	.639	.644	.634	.643	.442
Math variables					
Parcels 1	.768	.761	.775	.771	.741
Parcels 2	.803	.800	.805	.804	.816
Parcels 3	.794	.791	.798	.794	.765
Parcels 4	.705	.709	.701	.706	.654
Parcels 5	.428	.422	.435	.430	.355
Factor correlation					
Reading vs. math	.692	.690	.693	.718	.465

These results (Table 97, Table 98, Table 99, and Table 100) indicate that:

1. Findings from the two cross-validation samples are very consistent and provide evidence for the validity of analyses.
2. Structural models show a better fit for non-LEP than for LEP students.
3. Correlations between parcel scores and the content-based latent variables are generally lower for LEP students.
4. Correlations between the content-based latent variables are generally lower for LEP students.
5. These results are all indicative of a possible language factor as a source of measurement error for LEP students.

Multiple Group Factor Analyses

In the previous sections, we reported the results of simple-structure confirmatory factor analyses showing the structural relationship of test scores between LEP and non-LEP students across the three content areas. The results of our analyses showed differences on factor loadings and factor correlations between LEP and non-LEP students. In additional analyses presented in this section, we created multiple-group factor models to test the statistical significance of such differences. We examined the hypothesis of invariance of factor loadings and factor correlations between LEP and non-LEP. Specifically, we tested the following null hypotheses:

1. Correlations between parcel scores and a reading latent variable are the same for the LEP and non-LEP groups.
2. Correlations between parcel scores and a science latent variable are the same for the LEP and non-LEP groups.
3. Correlations between parcel scores and a math latent variable are the same for the LEP and non-LEP groups.
4. Correlations between content-based latent variables are the same for the LEP and non-LEP groups.

Table 101 through Table 106 present results for testing the hypotheses of invariance between LEP and non-LEP. Table 101 summarizes the results of analyses for reading and math tests for Grade 10 and the data include fit indices for LEP and non-LEP, correlations between the parcel scores and the content-based latent variables (factor loadings), and the correlations between the latent variables. Hypotheses regarding the invariance of factor loadings and factor correlations between LEP and non-LEP were tested. Significant differences between LEP and non-LEP at or below .05 nominal levels were identified. These differences are indicated by an asterisk (*) next to each of the constraints. There were several significant differences between LEP and non-LEP on the correlations between parcel scores and latent variables. For example, on the math subscale, factor loadings between LEP and non-LEP on parcels 2 and 3 were significant. There was also a significant difference between LEP and non-LEP students on the correlation between reading and math latent variables.

Table 101

Site 3 Grade 10 SAT 9 Reading and Math Structural Modeling Results (Parcels Ordered by Item Number)

	Model #1 (DF = 75)		Model #2 (DF = 74)	
Goodness of fit				
Chi square	2938		2019	
NFI	.916		.943	
NNFI	.902		.933	
CFI	.918		.945	
Factor loadings	Non-LEP (N = 8,947)	LEP (N = 303)	Non-LEP (N = 8,947)	LEP (N = 303)
Reading variables				
Parcels 1	.677	.683	.679	.685
Parcels 2	.683	.612	.684	.613
Parcels 3	.738	.695	.739	.696
Parcels 4	.826	.816	.824	.812
Parcels 5	.693	.723	.690	.720
Math variables				
Parcels 1	.735	.763	.752	.788
Parcels 2	.659	.702*	.667	.716*
Parcels 3	.623	.730*	.592	.685*
Parcels 4	.724	.774	.722	.774
Parcels 5	.389	.471	.330	.391
Error correlation				
E10 vs. E8	—	—	.329	.365*
Factor correlation				
Reading vs. math	.719	.624*	.723	.622*

Note. E10 refers to the error associated with math parcels 5. E8 refers to the error associated with math parcels 3.

*Significant univariate invariance <.05.

Table 102

Site 3 Grade 10 SAT 9 Reading and Math Structural Modeling Results

	Model #1 Homogenous Parcels (DF = 75)		Model #2 Heterogeneous Parcels (DF = 75)	
Goodness of fit				
Chi square	1460		230	
NFI	.966		.995	
NNFI	.961		.996	
CFI	.967		.997	
Factor loadings	Non-LEP (N = 8,947)	LEP (N = 303)	Non-LEP (N = 8,947)	LEP (N = 303)
Reading variables				
Parcels 1	.473	.540	.773	.739
Parcels 2	.686	.622[a]	.793	.798
Parcels 3	.811	.776	.786	.771
Parcels 4	.880	.863	.838	.818
Parcels 5	.852	.844	.827	.798
Math variables				
Parcels 1	.405	.463	.689	.784
Parcels 2	.597	.698[a]	.723	.758
Parcels 3	.738	.796	.719	.791[a]
Parcels 4	.797	.837[a]	.760	.805
Parcels 5	.790	.846	.664	.735
Factor correlation				
Reading vs. math	.719	.624[a]	.723	.622[a]

[a]Significant univariate invariance <.05.

Table 103

Site 3 Grade 11 SAT 9 Reading and Math Structural Modeling Results

	Model #1 Homogenous Parcels (DF = 75)		Model #2 Heterogeneous Parcels (DF = 75)	
Goodness of fit				
Chi square	975		456	
NFI	.976		.990	
NNFI	.974		.989	
CFI	.978		.991	
Factor loadings	Non-LEP (N = 7,045)	LEP (N = 268)	Non-LEP (N = 7,045)	LEP (N = 268)
Reading variables				
Parcels 1	.611	.706[a]	.794	.794
Parcels 2	.765	.772	.804	.842
Parcels 3	.775	.792	.791	.754
Parcels 4	.851	.842	.816	.784
Parcels 5	.875	.847[a]	.831	.837[a]
Math variables				
Parcels 1	.491	.530	.759	.762
Parcels 2	.717	.753	.791	.810[a]
Parcels 3	.819	.846	.779	.801
Parcels 4	.849	.833	.830	.814
Parcels 5	.837	.872	.726	.707
Factor correlation				
Reading vs. math	.689	.619[a]	.678	.623[a]

[a]Significant univariate invariance <.05.

Table 104

Site 3 Grade 10 SAT 9 Reading and Science Structural Modeling Results (Parcels Ordered by Item Number)

	Model #1 (DF = 75)		Model #2 (DF = 74)	
Goodness of fit				
Chi Square	2074		1794	
NFI	.929		.938	
NNFI	.914		.924	
CFI	.930		.940	
Factor Loadings	Non-LEP (N = 8,918)	LEP (N = 264)	Non-LEP (N = 8,947)	LEP (N = 303)
Reading Variables				
Parcels 1	.683	.682	.686	.685
Parcels 2	.688	.622	.691	.624
Parcels 3	.741	.704	.742	.704
Parcels 4	.822	.797	.819	.792
Parcels 5	.689	.692	.684	.685
Science Variables				
Parcels 1	.665	.614	.680	.626
Parcels 2	.563	.535	.563	.537
Parcels 3	.650	.620	.616	.586
Parcels 4	.457	.433[a]	.406	.384[a]
Error Correlation				
E9 vs. E8	---	---	.201	.202
Factor Correlation				
Reading vs. Science	.808	.888[a]	.825	.909[a]

Note. E9 refers to the error associated with reading parcel. E8 refers to the error associated with reading parcel 3.

[a]Significant univariate invariance <.05.

Table 105

Site 3 Grade 10 SAT 9 Reading and Science Structural Modeling Results

	Model #1 Homogenous Parcels (DF = 58)		Model #2 Heterogeneous Parcels (DF = 58)	
Goodness of fit				
Chi square	760		233	
NFI	.978		.995	
NNFI	.975		.994	
CFI	.980		.996	
Factor loadings	Non-LEP (N = 8,918)	LEP (N = 264)	Non-LEP (N = 8,918)	LEP (N = 264)
Reading variables				
Parcels 1	.480	.539	.774	.749
Parcels 2	.686	.620	.794	.803
Parcels 3	.811	.792	.789	.776
Parcels 4	.878	.848	.837	.811
Parcels 5	.853	.843	.828	.785
Science variables				
Parcels 1	.619	.613	.709	.703
Parcels 2	.620	.628	.525	.498
Parcels 3	.676	.635*	.675	.653
Parcels 4	.666	.645	.711	.681
Factor correlation				
Reading vs. science	.746	.807*	.740	.791

*Significant univariate invariance <.05.

Table 106

Site 3 Grade 11 SAT 9 Reading and Science Structural Modeling Results

	Model #1 Homogenous Parcels (DF = 75)		Model #2 Heterogeneous Parcels (DF = 75)	
Goodness of fit				
Chi square	806		193	
NFI	.974		.994	
NNFI	.970		.995	
CFI	.976		.996	
Factor loadings	Non-LEP (N = 6,932)	LEP (N = 244)	Non-LEP (N = 6,932)	LEP (N = 244)
Reading variables				
Parcels 1	.788	.801	.797	.794
Parcels 2	.696	.674	.819	.842
Parcels 3	.790	.772	.798	.810
Parcels 4	.807	.786	.801	.808
Parcels 5	.815	.861[a]	.780	.787
Science variables				
Parcels 1	.433	.411	.666	.639
Parcels 2	.666	.594	.697	.663
Parcels 3	.772	.713	.756	.719
Parcels 4	.821	.791	.779	.722
Factor correlation				
Reading vs. science	.765	.848[a]	.725	.783[a]

[a]Significant univariate invariance <.05.

Table 102 through Table 106 present similar results for other content areas in Grades 10 and 11. The data in these tables show trends that were similar to those reported in Table 101. The results of our analyses, reported in these tables, suggest that the structural relationships of test items across the different content areas were different for the two groups. These results, which were consistent across the content areas and across the two grades, strongly suggest that major differences exist between the two groups of subjects, and that the two groups should be considered the same with respect to measuring their content knowledge.

Discussion

The purpose of this study was to examine the impact of students' language background on the outcome of their assessments. Three major research questions guided the analyses and reporting and will be the basis for discussion of the results:

1. Could the performance difference between ELL and non-ELL students be partly explained by language factors in the assessment?
2. Could the linguistic complexity of test items as a possible source of measurement error influence the reliability of assessment?
3. Could the linguistic complexity of test items as a possible source of construct-irrelevant variance influence the validity of the tests?

For our extant data analyses, we have been fortunate to have access to several large school districts nationwide. Complete item-level data on standardized achievement tests along with student background variables, including language background variables, were obtained from different sites across the nation. Among the student background variables were family SES, ethnicity, gender, and parent education. However, it must be noted that the data files from the various sites were different in many aspects. Different tests (such as Stanford 9 and ITBS) were used by different sites. The student background variables also varied from site to site. Some sites provided data on student free/reduced-price lunch program participation as an index of family SES. At some sites we had access to other SES variables such as AFDC; at other sites there were not any data on student SES. Among the major difference in the data across the different sites was the operational definition of ELL status. Some sites provided student ESL status, some provided ELL status, and others provided bilingual program participation status.

In spite of some differences between the structures of data from the different data sites, the results of the analyses on some major issues were consistent within and across the sites. Results of our analyses indicated that ELL students generally perform lower than non-ELL students in all subject areas, and particularly so in those areas with more language demand. For example, the results of this study consistently demonstrate that the performance gap between ELL and non-ELL students is smallest (and in some cases non-existent) in content areas with a low level of language demand, such as math computation, and is largest in content areas with a high level of language demand, such as reading and writing. The fact that the gap between the performance of ELL students and native English speakers increases

as the language demand of the items increases provides strong evidence of the impact language demand has on content area performance.

A major finding of this study was lower reliability/internal consistency for the ELL students. The results of our analyses indicated that test items for ELL students, particularly ELL students at the lower end of the English proficiency spectrum, suffer from lower internal consistency. Structural relationships between test scores for ELLs and native English speakers are different. For ELLs, the structural relationships are weaker. We speculated that this is due to language. That is, language factors introduce another source of measurement error into the structural models for ELLs.

The results of multivariate analyses, which were cross-validated, indicated that student family characteristics might be more important than what we originally thought. For example, parent education proved to be an important variable when studying the impact of language on performance. In a multiple regression with content-based test scores (math and reading), gender, and ethnicity as predictor variables, ethnicity showed the highest predictive power in predicting student bilingual status. The item-level analyses indicated that some test items from the standardized achievement tests were shown to be more difficult for ELLs. We identified those items and we cross-validated our findings with another groups of students.

We can now discuss findings of this study in response to the specific research questions raised earlier in this section.

Question 1. Could the performance difference between ELL and non-ELL students be partly explained by language factors in the assessment?

In response to this research question, results from the analyses of data from several locations nationwide indicated that students' assessment results might be confounded with language background variables. Descriptive statistics comparing ELL and non-ELL student performance by subgroup and across different content areas revealed major differences between the performances of the two groups. Included in the descriptive statistics section was a Disparity Index (the Disparity of performance of non-ELL over that of ELL students). This index showed major differences between students with different language backgrounds. The higher the level of English language complexity in the assessment tool, the greater the Disparity Index (the performance gap between ELL and non-ELL students).

Access to student-level and item-level data from the sites provided opportunity to conduct analyses on student subgroups that were formed based on their background variables, including language background. The exceptionally large numbers of students in some subgroups enabled us to conduct cross validation studies to demonstrate consistency of results over different sites and grade levels. The high degree of consistency assured us of the validity and interpretability of the results.

Descriptive analyses revealed that ELL students generally perform lower than non-ELL students on reading, science, and math subtests. The level of impact of language proficiency on assessment of ELL students was greater in content areas with a higher level of language demand—a strong indication of the impact of English language proficiency on assessment. For example, analyses show that ELL and non-ELL students had the greatest performance differences in reading, and the least performance differences in math, where language has less of an impact on the assessment.

Question 2. Could the linguistic complexity of test items as a possible source of measurement error influence the reliability of assessment?

In response to Question 2, the results of our analyses indicated that test items for ELL students, particularly ELL students at the lower end of the English proficiency spectrum, suffer from lower internal consistency. That is, the language background of students may add another dimension to the assessment in content-based areas. Thus, we speculated that language might act as a source of measurement error in such areas. It is therefore imperative that test publishers examine the impact of language factors on test reliability and publish reliability indices separately for the ELL subpopulation.

Question 3. Could the linguistic complexity of test items as a possible source of construct-irrelevant variance influence the validity of the tests?

To shed light on the issues concerning the impact of language factors on validity (Research Question 3), concurrent validity of standardized achievement tests (Stanford 9 and ITBS) was examined using a latent-variable modeling approach. Standardized achievement latent variables were correlated with the external-criterion latent variables. The results suggest that: (a) there is a strong correlation between the standardized achievement and external-criterion latent variables; (b) this relationship is stronger when latent-variables rather than

measured variables are used; and (c) the correlation between standardized achievement and external-criterion latent variables is significantly larger for the non-ELL than the ELL population. We speculate that low correlation between the two latent variables for the ELL group stems from language factors. That is, language factors act as construct-irrelevant sources (Messick, 1994).

Analyses of the structural relationships between individual items and between items with the total test scores revealed a major difference between ELL and non-ELL students. Structural models for ELL students demonstrated lower statistical fit. Further, the factor loadings were generally lower for ELL students and the correlations between the latent content-based variables were weaker for ELL students.

The results of this study suggest that ELL test performance may be explained at least partly by language factors. That is, linguistic complexity of test items unrelated to the content being assessed may at least be partly responsible for the performance gap between ELL and non-ELL students. Based on the findings of this study, we recommend that: (1) the issues concerning the impact of language factors on the assessment of ELLs should be examined further; (2) psychometric characteristics of assessment tools should be carefully reviewed for ELLs; and (3) in assessing ELLs, student language background variables should always be included, and efforts should be made to reduce confounding effects of language background on the assessment outcome.

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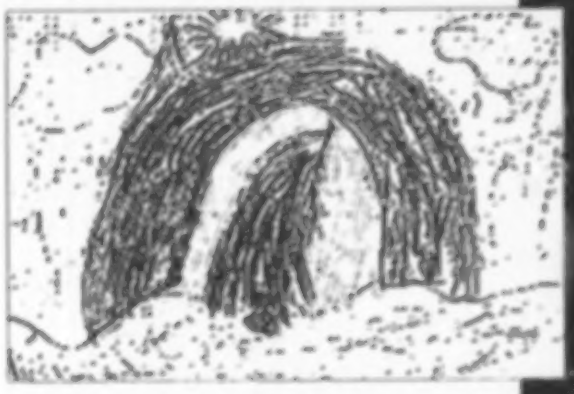
APPENDIX

ACRONYMS

The following is a list of acronyms used throughout the report.

AFDC ..... Aid to Families with Dependent Children
ANOVA ..... Analysis Of Variance
CDF ..... Cumulative Distribution Function
CFI ..... Comparative Fit Index
CRESST ..... National Center for Research on Evaluation, Standards, and Student Testing
DBN ..... Difference between Bilingual and Non-bilingual
DI ..... Disparity Index/Indices
DTI ..... Differential Treatment Index
ECDF ..... Empirical Cumulative Distribution Function
ELL ..... English Language Learner
EO ..... English Only
FEP ..... Fluent English Proficient
GPA ..... Grade Point Average
ITBS ..... Iowa Tests of Basic Skills
LAS ..... Language Assessment Scales
LEP ..... Limited English Proficient
M ..... Mean
MANOVA ... Multivariate Analysis of Variance
MR ..... Multiple Regression
n ..... Number
NAEP ..... National Assessment of Educational Progress
NCE ..... Normal Curve Equivalent
NFI ..... Normed Fit Index
NNFI ..... Non-normed Fit Index
NPR ..... National Percentile Rankings
OTL ..... Opportunity to Learn
QQ ..... Quantile-quantile
RFEP ..... Re-designated Fluent English Proficient
SAT ..... Scholastic Aptitude Test
SAT 9 ..... Stanford Achievement Test Series, Ninth Edition
SD ..... Standard Deviation
SWD ..... Students With Disabilities
SES ..... Socioeconomic Status



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